PUBLIC WORKS

CITY COUNTY STATE

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CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

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Water Works Pumping Plants

Relative Numbers of the Different Types of Plants in Use in the Different Sections of the Country, and of Those Recently Installed; On the Basis of Special Reports From Nearly Six Hundred Plants

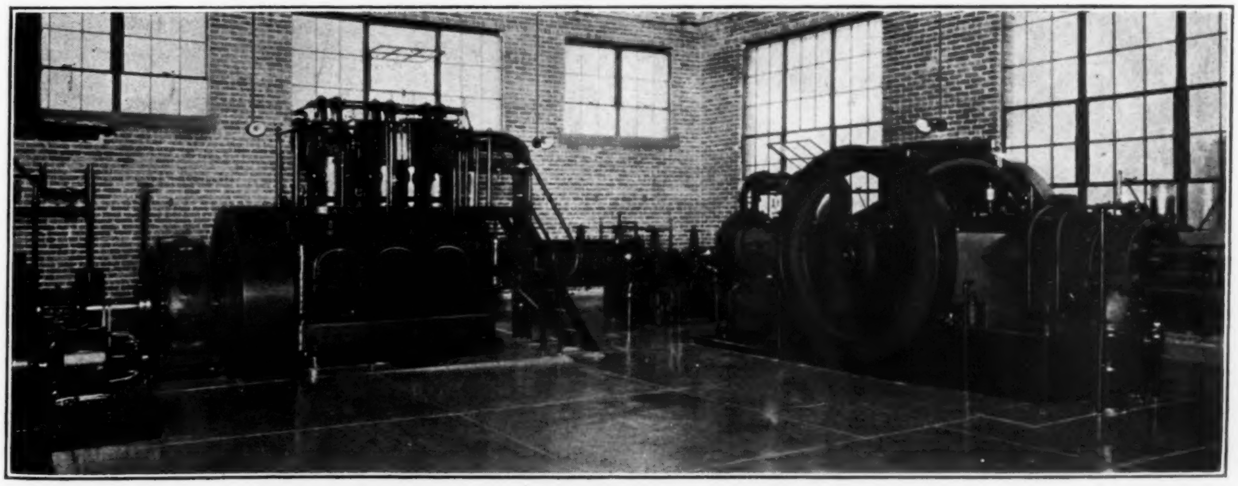
In pipes, valves and other parts of a distribution system, practically the same materials and devices are used as a generation ago, except for some minor changes in manufacturing methods, new pipe jointing materials, etc. Reservoirs also have changed in minor details only, and the same is true of most of the elements of a water works system except the pumping plant. But in this the recent changes have been almost radical.

Until a comparatively few years ago, direct-acting steam engines were about the only ones considered, except for a few plants using water power. Then came the use of gas and gasoline internal combustion engines, steam turbines, electricity, and oil engines; the last only recently taking their place as an economical and frequently desirable source of power for pumps and dynamos.

A questionnaire sent last month by PUBLIC WORKS to the water works superintendents of the country brought replies from six hundred concerning their pumping plants. Quite a number of cities have gravity supplies and are not, of course, included in this number. The replies of these superintendents have been tabulated and are published in this issue. An analysis of them and summaries by state groups bring out some interesting points and are given below.

Looking at the table showing, by geographical divisions, the kinds of pumping plants in regular service, the first point noticed is the fact that more than half the cities use electrically operated pumps; that steam is second, and that no others even approach these. Ninety-two cities use more than one kind—generally two—in regular service, either in the same station or, more commonly, in different stations. Considering each such city as a half unit for each of the kinds of plant used, and combining these half units with the others, we have the percentages given in this table. These show that 92 per cent of the plants are either electric or steam, with oil leading the other kinds.

Electric predominates most on the Pacific coast, with the Mountain division next and the South Atlantic third. The reason for this is



GENERAL VIEW OF PLANT OF ELMHURST, ILL., WATER WORKS.
At left, oil engine direct connected to generator. At right, air compressor.

Kinds of Pumping Plants in Regular Service—By Divisions

Figures in parentheses indicate number of cities in which this is one of two or more kinds of plants.

Divisions	Electric No.		Electric %	Steam No.		Steam %	Oil No.		Oil %	Gasoline or Gas No.		Gasoline or Gas %	Hydraulic No.		Hydraulic %
New England	17	(6)	37	19	(5)	39¾	4	(2)	9	1		2¼	6	(1)	12
Middle Atlantic	29	(6)	44⅔	32	(5)	48¼	..		..	1	(2)	2¾	2	(2)	4⅓
East North Central	53	(27)	42¾	64	(26)	49¾	4	(2)	3¼	3	(2)	2½	3		1¾
West North Central	50	(17)	67¼	19	(14)	29¾	..	(3)	1¾	..	(2)	1¼	..		..
South Atlantic	31	(10)	73½	6	(8)	20½	1		2	1		2	..	(2)a	2
East South Central	16	(7)	50	15	(7)	47½	1		2½	..		..	..		..
West South Central	27	(10)	68	6	(10)	23½	2	(1)	5⅓	1		2 1/6	..	(1)	1
Mountain	15	(1)	81½	1	(1)	8	2		10½	..		..	..		..
Pacific	24	(3)	85	1	(3)	8⅓	..		..	1		3⅓	1		3⅓
Total	262	(87)	55⅓	163	(79)	36⅔	14	(8)	3¼	8	(6)	2	12	(6)	2¾

a—Also 2 hydro-electric plants.
Combination plants are reported in 92 cities; giving the total number of cities represented above as 551.

Kinds of Pumping Plants in Reserve—By Divisions

Divisions	Electric No.		Electric %	Steam No.		Steam %	Oil No.		Oil %	Gasoline or Gas No.		Gasoline or Gas %	Hydraulic No.		Hydraulic %
New England	9	(7)	25½	27	(5)	60	4	(1)	9¼	1		2	1	(1)	3¼
Middle Atlantic	18	(3)	31½	29	(4)	50	6		9¾	4	(3)	8¾	..		..
East North Central	23	(8)	22½	70	(8)	61	3	(3)	3¾	11	(5)	11¼	2		1¾
West North Central	11	(6)	20¼	47	(5)	71¾	1		1½	3	(3)	6½	..		..
South Atlantic	9	(4)	27	20	(3)	52½	1	(1)	3½	7		17	..		..
East South Central	5	(2)	19½	21	(3)	72½	..		..	2	(1)	8	..		..
West South Central	12	(6)	41⅔	12	(6)	41⅔	3	(2)	11	2		5⅔	..		..
Mountain	9	(1)	52¾	4		22¼	2		11	2	(1)	14	..		..
Pacific	7	(4)	41	7	(3)	38¾	..	(1)	2¼	3	(2)	18	..		..
Total	103	(41)	27½	237	(37)	57	20	(8)	5¼	35	(15)	9½	3	(1)	¾

Combination plants are reported in 50 cities; giving the total number of cities represented above as 448. Of these, 7 have gravity supplies for regular service.

Changes Made During Past Five Years

Division	Steam to Electric	Gasoline to Electric	Steam to Oil	Electric to Oil	Oil to Electric	Electric to Steam	Hydraulic to Electric	Gasoline to Oil
New England	4	..	1	..	..	..	..	..
Middle Atlantic	9	3	..	..	..	1	..	1
East North Central	24	..	2	2	1	1	1	..
West North Central	17	..	..	..	..	1	..	..
South Atlantic	6	1	..	..	1	..	..	..
East South Central	5	..	..	1	..	..	..	..
West South Central	4	1	2	..	1	..	..	..
Mountain	..	..	..	..	..	..	..	..
Pacific	2	..	..	..	..	..	1	..
Total	71	5	5	3	3	3	2	1

quite evident when we consider that in these sections large hydro-electric plants distribute current over a large part of the total area and sell it at very low figures compared to the cost of fuel in the respective localities.

While New England also has water power, most of it is utilized by small plants and current generated is used locally. Here we find the lowest percentage of electric pumping plants, but about half of the hydraulic plants of the country.

Steam is used by practically half of the plants in the Middle Atlantic, East North Central and East South Central divisions; by about 40 per cent of New England plants, and to a very much less degree by all the other divisions. This distribution is due to a combination of several conditions—comparatively high cost of fuel and low cost of electric current; age of plant, most of the older plants having used steam and many having not thought it necessary to change; and size of plant, steam being most economical in large plants.

Of the plants giving adequate reports, 110 or twenty per cent do not report any reserve or stand-by pumping service. Several reported duplicate plants (used alternately, we hope, to keep both in good operating condition for instant service in emergencies), and the same may be true of a few of these 110 that did not report any stand-by plants.

The kinds of plants kept as reserve are shown in another table herewith. Here steam is even further in the lead than electric was in the service plants; electric next; gasoline occupies third place; and of hydraulic plants there is less than one per cent.

The reason for the high percentage of steam plants is undoubtedly that these have been replaced by other types, which are more economical and are used for regular service; although the steam pumps are still too good to discard and are retained for occasional use. In every division except the Middle Atlantic, more of the plants reporting have steam in reserve than use it in regular service.

In quite a number of plants which have substituted electricity for steam, not only is the old steam plant retained, but a duplicate electric plant is installed also; and a number of electric plants are installed in duplicate where there had not previously been any plant.

CHANGES MADE RECENTLY

In reply to a question as to what changes had been made during the past five years in kind of plant, only 93 replied definitely, although quite a number of others named the kind of the new plant installed without stating what it took the place of.

Of these 93, 71 reported changing from steam to electric; 5 changed from steam to oil, 5 from

gasoline to electric, 3 from oil to electric and 3 from electric to oil. The figures by divisions are shown in the third accompanying table.

One class of changes that interested us was the change from electric to steam, of which three instances were reported. Of these, Hartford, Wisconsin, was one, and H. J. Peters, superintendent of the Utilities Department, explains the reason as follows: An abundance of underground water is available at Hartford, and is pumped from five wells distributed about the city, all of which are equipped with electrically driven pumps. Formerly whenever it was necessary to close down the city's power plant, it meant stopping all the pumps. Therefore, one unit at the power plant was changed from electric to steam, so that when it is necessary to close down the electric plant it is still possible to pump with the steam-driven unit. One of the other superintendents stated that personally he was opposed to the change, but failed to explain why it was made.

Following this discussion will be found several articles in which superintendents of water departments describe some of the more interesting features of different types of pumping plants operated by them. The first of these is interesting as comparing three different types, two operated in regular service and the third as a reserve.

Pumping by Water Power, Electricity and Steam

Learning that Putnam, Conn., is using three types of pumping plants, water power, steam and electricity, we asked the superintendent of the Water Department, C. Dwight Sharpe, to make, for the information of our readers, a comparison of these three types as used at Putnam, and he has kindly furnished the following information.

The average consumption of the city is a little under a million gallons a day, but hose use and other consequences of dry times in summer run it considerably above this.

The principal pumping is done by water power, which has a capacity of 1,200,000 gallons a day, water for pumping being taken from the same stream that furnishes the supply, which is filtered before being sent into the mains. During a considerable part of the year, the stream furnishes just about enough water, in excess of the consumption, to do the pumping, 12 to 14 gallons through the wheel being necessary for pumping one gallon. When the consumption is high (in excess of 1,200,000 gallons a day) the water wheel has not sufficient power to do all the pumping. When, in addition, the stream flow is low, sufficient excess water is not available to run the water wheel to even this capacity. Consequently a supplementary power is necessary. Steam was used for this until three or four years ago, when an electric pump was installed, since which time the steam plant has not been used, except occasionally to make sure that it is in condition for use if needed. If steam were used as an auxiliary it would be necessary to carry steam in the boiler all the time, requiring a useless consumption of coal, while the electric pump can be thrown into service immediately whenever wanted. When the water power is not sufficient, the electric is used just long enough to catch up, and then the water power runs alone again. The steam pump has a capacity of 1,325,000 gallons, the electric pump pump, 1,875,000 gallons.

The plant is operated by one man by day and one by night, who also operate the filters. The oil and supplies for the three different types of plant would not vary much; consequently these items are omitted in comparing the relative costs.

Power for the water power costs nothing.

Coal for the steam plant costs $11 per ton delivered at the station, or 0.55 cts. per pound. Pumping with steam requires about one pound of coal for 150 gallons or 3.7 cts. per 1,000 gallons. These were the figures when steam was the principal pumping unit. It would undoubtedly be considerably greater if steam were used as an auxiliary.

Current for the electric plant costs 1.2 cts. per k.w.h. plus .0045 times the coal charge, the contract being based on $5 coal. There is also a service charge of $76.67 per month, which brings the cost up to 2.6 cts. per k.w.h. As the electric pump pumps 754 gallons per k.w.h this gives the cost per 1,000 gallons as 3.5 cts. If the electric were run continuously, Mr. Sharpe is certain that the cost would be less, because at peak draught the pump would throw more water than was used as the basis of these figures. As the steam figures were on the basis of continuous pumping, there would seem to be an appreciable saving in using electricity. As the amount of water pumped increases with increased consumption, these figures will naturally decrease.

An additional advantage of electric power for the auxiliary is its availability in an emergency, nd the labor involved in using steam.

Elmhurst's Oil Engine Plant

Elmhurst, Ill., a suburb of Chicago, has recently changed its pumping plant from electricity to a Diesel oil engine, and the City Superintendent, H. S. Crockett, has kindly furnished us with information from which the following description has been prepared.

The city was served by a private water company until December 20, 1920, when its franchise expired. Meantime the municipal authorities had, in 1916, sunk a 975-foot artesian well yield-

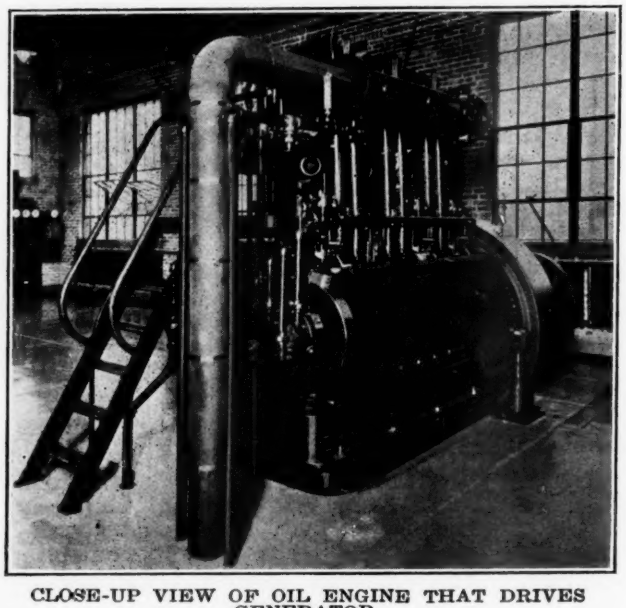
ing 185 gallons a minute, and in 1918 a 1,400-foot well yielding 620 gallons a minute, which water had been sold to the company. The former well was provided with a deep-well pump, the latter with an air lift. The city had also laid a distribution system of cast iron mains (the company's were of wood); and when the franchise expired, took over the water works service, using the new system for serving the 750 consumers. By January, 1922, there were 1,600 consumers, with services all metered.

The more than doubling of the consumption necessitated a new pumping plant to replace two 5-inch motor-driven centrifugal units previously used, and a contract for a new plant was awarded in 1922 to the Ingersoll-Rand Co. This included also substituting an air lift for the deep-well pump in the first well, by which the flow was increased from 185 to 630 gallons a minute.

The water raised from the wells is discharged by the air lift into a basin, from which it is repumped into the mains and an elevated tank by a centrifugal pump. Both this pump and the main air compressor are operated by an oil engine. The old air-lift plant, which was in the basement of the city hall, is driven by electricity furnished from a power plant in the main station consisting of another oil engine direct connected to a generator.

The pump is a Cameron 5-inch, single-stage, double-suction centrifugal, belt-driven from the fly-wheel of the oil-engine-driven compressor. By operating the air compressor at half capacity by means of hand-operated clearance pockets, the pump can handle all the water raised into the basin by the air lift. This compressor unit consists of a horizontal, single-cylinder oil engine direct connected to a horizontal, single-cylinder, single-acting, 2-stage air compressor.

The engine is of the 4-cycle, solid-injection, cold-wall pattern, that delivers 93 B.h.p. at 240 r.p.m., using not more than 0.45 pound of fuel oil (18,500 B.t.u. per pound) per brake-horse-power hour at full or three-quarter loading, or 0.48 pound at half load. With oil at 5½ cents, the fuel cost is 0.87 cent per 1,000 gallons pumped from the well and delivered into the mains against a head of 43 pounds.



CLOSE-UP VIEW OF OIL ENGINE THAT DRIVES GENERATOR.

The 80KVA Westinghouse generator is direct connected to a 3-cylinder, vertical, Price-Rathbun oil engine. This provides current for operating the compressor and pumps of the older installation should the new compressor be out of commission. Electric current is being put on the switchboard for less than 0.75 cent per k.w. One gallon of oil, costing 67 cents, lasts 4,000 horsepower-hours. The output averages 60 k.w. Next summer the city will install a street lighting system and use the current for that also. The labor cost is $360 per month, but was just as great when current was bought from the company. Formerly the city paid the Public Service Company 2.5 cents.

The plans for this unusual system were laid out by Mr. Crockett, who was appointed City Superintendent of Elmhurst in the spring of 1920.

Stevens Point Pumping Station

By J. R. Weyher*

During the war and shortly afterward, when coal was at a premium, the Water Company of Stevens Point, Wis., found itself forced to either close down or change its plant so that it could utilize electricity. Fortunately Stevens Point is so situated that there are eight hydro-electric plants sending power to the city. The company made the change to electric drive and has found it so satisfactory that the entire plant, which is now owned by the municipality, has been electrified. By making the change we have eliminated labor troubles, reduced the cost of power about 60% and are able to render better service to the consumers. We furnish continuous, steady pressure at all times, the pumping station being located in the extreme eastern end of the city and the standpipe in the extreme western end. We have a rate for current that totals approximately 1.4c per kilowatt.

We are contemplating installing as an auxiliary a gasoline driven pump, but it is a question whether we will be financially able to do so this year.

The writer has had eighteen years' experience in waterworks and believes that he is justified in recommending electric drive in view of the following facts:

In building our new plant in the fall of 1922 (which plant is described below) provision was made for a station of approximately 8,000,000 gallons per day capacity, but the pumps occu-

*Superintendent of Stevens Point Water Company.

STEVENS POINT PUMP HOUSE AND WELL.
30-foot covered well at left of pump house.

pied a combined floor space not much greater than that needed for one of the old 2,000,000-gallon steam pumps.

By installing a number of electric drive units at relatively small cost, we are able to get a far more flexible plant than with steam, since the cost of an equal number of steam units and a building to house them would be prohibitive.

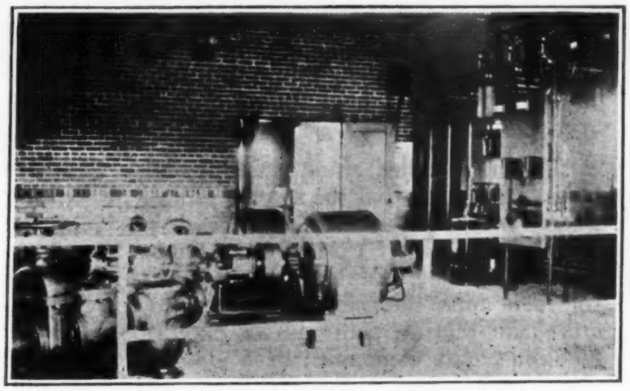
The writer, however, would not advise electrification of a water utility without also having a stand-by unit of some sort to provide for a possibility of power being cut off or the plant put out of commission by a severe electrical storm.

The new plant referred to above was one designed by W. G. Kirchoffer, who was employed in the fall of 1921 to locate a suitable palatable supply for the city. After several weeks he located a supply of very soft water which was developed by sinking a well 30 feet in diameter and 33 feet deep, constructed of concrete. This was begun in July, 1922, and the new supply was turned into the distribution system in February, 1923. Since then no trouble has occurred at this plant with the exception of a slight burnout due to lightning in the spring of 1923. In addition to sinking the well, the new building was constructed and 20,000 feet of pipe laid. The well was constructed by the Cast Stone Construction Company of Eau Claire, the pipes were laid by the Vicker Company of Stevens Point, while the pumps and the General Electric motors operating them were furnished by the Cameron Steam Pump Works, and the switchboard by the Wisconsin Switchboard Company.

Hydrogen-ion Correction at Waterford

The Water Department of Waterford, N. Y., has recently had an interesting experience with the use of sulphuric acid for hydrogen-ion correction, and while the superintendent, R. G. Yaxley, does not feel that the experiments have yet progressed far enough to justify any final conclusions or warrant an extensive description, he has kindly furnished us with the following notes concerning the experiment:

"Our water supply, the Hudson river, is a stream that in the summer season has almost no turbidity, is high in color and organic matter



STEVENS POINT PUMPING STATION.
2,000,000-gallon pump at left foreground.

and is very badly polluted from a sanitary standpoint. Coagulation is difficult except with heavy dosage of alum, 4 to 4½ gr. per gallon being common during July, August and September. At one time last season while we were using over 6 gr. per gallon we experimented in a crude way with acid and by the addition of 0.8 gr. of 66 B. acid we were able to get excellent results with a 3 gr. dose. The winter conditions are much better as regards the amount of alum required, but considerable trouble has been experienced in the past with fine floc going through the filter beds, which caused short filter runs and excessive use of wash water.

"We started the regular use of acid the latter part of January this year, and below I have prepared a table comparing this season with the past few years.

AMOUNTS USED, GRAINS PER GALLON

Five-Year Average.

Feb.	Alum	2.9	Lime	.5
Mar.	"	2.5	"	.5
April	"	2.3	"	.6

Results this season.

Feb.	Alum	1.6	Lime	.0	Acid	.55
Mar.	"	1.8	"	.25	"	.51
April	"	1.3	"	1.00	"	.33

Note: Lime used to correct free CO_2. Cost of alum and acid about equal in plant.

"Certain changes in operating methods prevent using over a two-year average on amounts of wash water required, but using that as a basis of comparison, our saving in wash water has amounted to about 17%, which, of course, is accompanied by a higher sedimentation basis efficiency.

"From both chemical and financial standpoints it looks good. Of course, we have had mechanical troubles handling the acid, but I think that this part of the problem can be solved. We were much pleased to find that the treatment was a success from an alum-saving standpoint during the winter months, as laboratory experiments had led us to believe otherwise and our efforts had been planned along the line of improvement of coagulation rather than a saving in chemicals at that time of the year. Our main savings were expected to be in the summer months, and from present indications will work out about as expected."

New Bedford Waterworks Notes

Like many other cities, recently, New Bedford, Mass., has found that the income from its municipal waterworks was not sufficient, and last year the Water Board, after careful study and advice from the city solicitor, adopted new methods of charging for main pipe extensions. One of these was a requirement that all petitions for extensions of main pipe must be accompanied by a guarantee of an income from such line of pipe equal to 6% of the estimated cost of laying the same based on the average actual cost during the preceding year.

In the matter of meters, it was decided that in all cases where repairs of meters are charged to owners or takers, the full cost of the repairs be included. Charges for installing a service to a property from the main to the street line were fixed at $27.50 for a ⅝-inch service, $30 for a ¾-inch and $35 for a 1-inch; the owner paying the entire cost of the work where a service is carried beyond the property line. Rental of meters installed within the basement wall of a house was fixed at $1.50 per year for a ⅝-inch meter, $2 for a ¾-inch and $3.25 for a 1-inch. For large-size meters and unusual cases where a meter box was located in the street or elsewhere outside of the house, the rental is 10% of the cost of meter and installation.

One of the reservoirs of the city is known as "Little Quittacas Pond." The water in this pond was lowered from May 1 to June 12 in order that the shores might be cleared of the growth of grass and weeds and also to dry out the ground around the shores in order to facilitate the laying of a new intake to the pump well. This was taken advantage of to learn the yield of water from the ground into the pond—that is, the available ground storage around the reservoir. The amount used during this period was measured, careful determinations were made of rainfall and evaporation, and the excess of evaporation over rainfall was added to the amount pumped; the sum, or 488,199,000 gallons, being the total removed from the reservoir.

The contents of the reservoir at different elevations had been very accurately determined, and the elevation of the water at the beginning and ending of the period showed that the difference between the contents of the pond at these two elevations was 354,728,000 gallons. This showed that there had been withdrawn from the pond 133,471,000 gallons more than would be accounted for by the lowering of the water-level. This was approximately one-sixth of the amount of water in the pond at the higher elevation. This rate of ground yield, which averaged 3,177,881 gallons a day, was undoubtedly exceeded during the early part of this period and decreased during the latter part and would obviously continue to decrease if the pond had been kept lowered.

The vegetable growth was largely cleared from shores, leaving these gravelly and presumably improving the quality of the water. It was expected tc eliminate vegetable tastes and odors which sometimes occurred in this pond.

JOINT USE OF WATER SUPPLIES

For some years an effort has been made by the cities of Fall River, Taunton and New Bedford to come to some arrangement whereby they may make a joint use of what is known as the Lakeville ponds. In this much assistance has been rendered by X. H. Goodnough, chief engineer of the State Department of Health, and an equitable arrangement whereby the cities could use these ponds jointly was worked out by him, based partly on a prediction of population and consumption up to the year 1960, until which date it is believed that the ponds will furnish ample water for all three cities. The mayors and waterworks representatives of these three cities agreed upon a bill to be submitted to the legislature permitting the use of Long, Assawompsett and Pocksha ponds by these three cities and the towns of Middleboro and Lakeville, and it is hoped that this bill will be passed by the legislature, obviating the necessity of a state commission, with the consequent expense.

The principal features of the bill agreed upon are that Fall River is to obtain full control and make full use of North Watuppa pond; after using this Pond to its limit, it shall take from Long Pond the additional amount needed, but not exceeding nine million gallons a day, and shall maintain a difference in level of not over 6 inches in the two ponds, which condition would permit 7,000,000 gallons per day to flow into Assawompsett Pond for the use of the other communities. New Bedford retains all its rights in the Quittacas Ponds and is permitted to draw not exceeding 14,000,000 gallons per day from Pocksha and Assawompsett Ponds. Taunton retains sole use of Elders Pond and is permitted to draw not exceeding 8,000,000 gallons per day from these two ponds. The total of the quantities named is believed to be the safe yield of these ponds over a period of dry years. In years of ordinary rainfall their capacity is much greater.

Some action of this kind was necessary, since Fall River has already reached the limit of safe yield of North Watuppa Pond and New Bedford is within one million gallons per day of the safe yield of the two Quittacas ponds.

Stone Block Production in 1923

The United States Geological Survey has recently made public figures relative to the production of stone for various purposes during the year 1923. Among the various classes of stone produced is that sold for use as paving blocks, which is reported to have increased about 48 per cent. over the 1922 output. In the case of granite paving blocks the increase was 50 per cent., but only about 13 per cent. in the case of sandstone blocks.

The sale of curbstones increased about 44 per cent. but that of flagstones decreased slightly.

Crushed stone represents more than half the stone quarried, and the sale in 1923 is estimated to have been 66 millio nshort tons, an increase of about 33 per cent. over 1922. Crushed stone used for railroad ballast increased about 76 per cent., while that used as road metal and inconcrete for road work and general construction increased about 25 per cent.

Brick Roads of Florida

Present condition of three hundred miles of brick pavements on Florida highways, laid on sand subgrades, as determined by an inspection made by the U. S. Bureau of Public Roads.

Brick roads in Florida are generally laid directly upon the sand subgrade. The brick are filled with sand, cement grout, or a bituminous filler, and are retained at the sides of the road by cypress, vitrified brick, or concrete curbs. The shoulders are sand, shell, clay, or limerock.

Brick pavements of this type have practically no "beam strength." Traffic loads are supported by the confined sand of the subgrade, the brick surface serving chiefly as a wearing course.

The cement-grout filled pavements offer less tractive resistance and more resistance to deterioration than the sand-filled roads. They distribute the wheel loads over a wider area of subgrade, but when they do break up, as they do when laid directly on the sand subgrade, the relaying value of the brick is much less than those of sand-filled pavements. If in the future this type of surface is laid with adequate base and shoulders and provision for expansion, it should make a very satisfactory pavement.

Sand-filled pavements in service from 8 to 14 years, receiving little or no intelligent maintenance, have 70 per cent of their surface functioning as fair and good road. The remaining 30 per cent, while in need of reconstruction, has a reconstruction value of 80 per cent of the new construction cost. Pavements of this type are believed to have been economical and well adapted to a State in which uncertain development precluded a forecast of future traffic conditions.

Sand is ineffective as a filler. It is not waterproof; it offers little frictional resistance to the movement of the brick; and it can not be retained in place.

Bituminous fillers have desirable waterproofing and plastic properties. They do not reduce the salvage value of the pavement.

Indications are that limerock dust, sand mixed with limerock dust or clay, or sand treated with a light oil, would make satisfactory fillers.

Indications are that the brick roads can be strengthened to accommodate heavy traffic or to hold up in locations where good drainage is impracticable by laying a base course of compacted limerock which will provide additional confinement of the sand subgrade. Such bases are not like rigid slabs which have "beam strength"; their strength does not lie in the bond between the individual stones as in the macadams; their chief value lies in their ability to remain at all times in contact with the sand subgrade. They have little supporting power in themselves, but they do make available the maximum support of the subgrade. They also prevent loss of sand through the crevices between the brick.

Shoulders of limerock or other material capable of providing side support for the pavement are more necessary than thick bases.

Florida State Highway Commission reports indicate a maximum daily traffic over such roads amounting to 200 motor trucks on the two-way road between Lakeland and Tampa and 157 on the narrow one-way road between Sanford and Kissimmee. The number of trucks averaged from 10 to 30 per cent of the total number of vehicles.

It is important to note that practically all of the Florida road traffic is carried on pneumatic tires, for it is quite probable that equally good results as herein reported would not have been secured had the heaviest trucks operated on solid tires. It should also be noted that Florida traffic is comparatively light. The gross load limitation is 16,000 pounds on pneumatic tired vehicles and 8,000 pounds on vehicles having solid tires.

The above is a brief statement of the conclusions of investigators of the U. S. Bureau of Public Roads after inspecting about 300 miles of brick pavement, exclusive of city streets. A full report, by C. A. Hogentogler, highway engineer of the Bureau, is published in the April issue of "Public Roads," the official journal of the Bureau. In this report illustrations are given of each of the points noted.

State route No. 1, Jacksonville to Lake City, illustrates the fact that sand-filled brick surfaces have little or no beam strength. This road, which is representative of Florida construction, has withstood

STATE ROUTE NO. 1 BETWEEN JACKSONVILLE AND LAKE CITY, SHOWING LACK OF "BEAM STRENGTH."

traffic for 14 years, including the war traffic of truck trains, gun mounts and carriages. While the surface is not in perfect condition, its principal defects are traceable directly to lack of stability, the one undesirable characteristic of the sand subgrade.

Deterioration of sand-filled surfaces is first indicated by a more or less uniform settlement along the curbs, accompanied in some instances by transverse separation of the brick. Later come well-defined grooves or edge depressions, loss of filler, movement of the brick and sometimes slight unevenness of surface. Finally come excessive rutting, separation and displacement of bricks, and unevenness of surface. But even deep groves do not as a rule impair the smooth riding qualities of the pavement, although inconvenient for vehicles turning out to pass each other.

Cement-grout-filled surfaces were found to crack, the cracks sometimes increasing in number until they divided the pavement into small blocks. In the final stages of deterioration, almost every brick becomes separated from those adjacent.

Of the 300 miles inspected, about 35 per cent retained excellent surface, showing no sign of deterioration or else a movement, settlement or cracking so slight as to require no immediate repair except in small, isolated areas. About 40 per cent showed marked loss of filler, appreciable cracking, brick movement, grooving and spread of curbs. On the remaining 25 per cent traffic was seriously inconvenienced or hindered by marked brick movement, loose bricks, etc. These percentages are based on classification of sections as a whole. If considered foot by foot, the first class would be increased.

Inadequate confinement of the sand subgrade was responsible for the major defects, this being due to insufficient side support.

The present value of brick pavements depends not alone on their condition, but also on the relaying value of the brick. This is low in cement-grout-filled pavements, but high in sand-filled and little less so in bituminous-filled. On one pavement laid in 1909 and relaid in 1919 the breakage of brick was less than 1 per cent. On another, 90,000 sq. yds. were relaid with only 650 sq. yds. of new brick required. It was concluded that, at the present price of brick, 70 per cent of the initial investment remained when the pavement had deteriorated to the point of requiring relaying. Bids for relaying the Orlando-Winter Garden road were $1.95 per square yard, or 80 per cent less than those for new construction.

While cement-grout-filled surfaces offered less resistance to traffic and more to deterioration than others, this advantage is not considered sufficient to compensate for breakage caused by blow-ups and loss of relaying value.

Sand-filled pavements were economical and especially well adapted to the conditions in Florida. Says Mr. Hogentogler: "When pavements which have been in service from 8 to 14 years, and which in that time in many cases have received little or no intelligent maintenance, have 70 per cent functioning as fair and good roads and the remaining 30 per cent, though in need of reconstruction, has a relaying value equivalent to 80 per cent of the new construction cost, such pavements can not be considered as other than satisfactory."

Sand filler, however, is very ineffective, and bituminous fillers seem desirable because of their waterproofing and plastic properties, and also because they do not reduce the salvage value of the pavements.

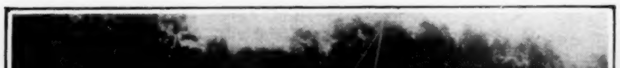
Highway Contracting in California

Highway work in California would seem to have superior attractions for the contractor who finds it monotonous to have nothing to do but draw his monthly estimates and pay his bills, and nothing to worry about but how to invest his profits to the best advantage.

The following appeared in the April issue of "California Highways," the official publication of the State Highway Commission:

In Memoriam

At 1.20 a. m., March 5, 1924, in the dead of night, the Bucyrus 30-B, full diesel shovel, belonging to George Pollock Company, contractors, tired of its endless labors, plunged headlong 500 feet over a precipice to a watery



GROOVES IN A NARROW SAND-FILLED BRICK SURFACE BETWEEN ST. AUGUSTINE AND HASTINGS.

BITUMINOUS-FILLED RELAID BRICK SURFACE BETWEEN JACKSONVILLE AND ATLANTIC BEACH, GIVING GOOD SERVICE, THOUGH IN THE FIRST STAGE OF DETERIORATION.

grave in the turbulent waters of the Pacific Ocean at station 186 Contract No. 395, V-Monterey-56-E.

No services were held as her plans were well executed and she now rests in the bosom of the Pacific, free from all earthly troubles.

No effort is to be made to recover the body.

A post-mortem investigation showed that about four feet of bank gave way allowing the shovel to slide off backwards, slowly. The operator escaped. The shovel hit only three times in the descent and the last plunge was over a cliff about 150 feet high, landing the shovel seventy-five feet into the ocean.

The remains may be seen at low tide.

A Narrow Escape

An example of the difficulties under which construction is progressing on the San Simeon-Carmel highway, south of the Big Sur River, in Monterey County, Division V, was the accident in which G. Corvin, a workman, nearly lost his life. A slide carried him to the brink of a canyon where he caught against some trees. Falling rocks crushed his foot and ankle and broke four ribs. J. M. Knapp, a field draftsman, rendered first aid.

It was necessary to remove the injured man forty miles to Monterey for treatment. The sea was rough and the contractor's boat, the usual means of communication, could not leave Monterey Bay. Ten men carried Corvin, on a stormy night, over slides and mountain trails to the nearest automobile road.

The suffering man reached Monterey within twenty-four hours, but it was found necessary to amputate his foot.

Quarantine Fails To Stop Highway Work On Malibu

After fighting gun men, lawyers, injunctions and barbed wire fences for several years, in an effort to keep construction work going on the Coast Boulevard through the Malibu Ranch, Los Angeles county, Division VII now has a quarantine on its hands.

Despite the fact that all roads leading to the day labor camp, north of Santa Monica, have been posted and are under observation by the Los Angeles health department, the work is progressing rapidly with thirty-five men and twenty head of stock on the job.

The fact that nine men are ill with smallpox has had no demoralizing effect and the crew is moving dirt as usual.

Highway Contracting—Its Illusions*

By T. J. Wasser†

Not so long ago road building was considered only a part of general contracting and was carried on by antiquated methods and equipment, with no respect for time. But today highway contracting is a highly specialized business, carried on successfully only with the use of modern type of machinery and the best grade of materials and when handled without delay in the shortest possible time in order to insure a profit on the money invested.

IRRESPONSIBLE BIDDERS

Into this field of highway contracting have come two types of contractors. First are the individuals, firms and corporations that were in the business when the modern hard-surfaced highway was first introduced and progressed with the movement for modern highways throughout the country, many at great loss and expense, but financially able to weather the experience and who today represent our successful highway contractors. The other class comprises the inexperienced individuals, firms and corporations that broke into the business in recent years with a vision of large profits, but who in reality had a lot of false ideas.

What are the results? Through lack of knowledge or experience of the newcomers, work is generally underbid, competition destroyed, capital lost, the work delayed, and the public that finances the work is dissatisfied because deprived of the use of the road for two or three times longer than is necessary to complete it.

On the other hand, when the job is awarded to an experienced contractor with sufficient capital to complete, and who does complete, the work satisfactorily and on time, with a small average margin of profit on the money invested (and not the large profits Dame Rumor would have you believe), you have a general satisfactory result.

How can the former condition be remedied?

First—By showing capital and inexperience that large profits are an illusion.

Second—By establishing a standard for comparing the two types of contractors, in order that the public may know.

Third—By making the standard of responsibility such that only after proven ability can a contractor enter into the competitive field of highway contracting.

Fourth—By obtaining the co-operation of those responsible for the conditions governing the design and supervision of the work.

Contracts for highway construction are awarded in sums up to a million dollars, the majority of contracts being valued at from $200,000 to $500,000. Naturally the percentage of profit that one is entitled to on such amounts is what attracts, and the ease with which one can qualify as a responsible bidder is the contributing primary cause of so many failures.

Before going into details, let me compare the two types of contractors referred to, because on the result of the comparison depends whether profits can be anticipated or failure assured.

Highway contracting is based on two fundamentals and four essentials.

The fundamentals are: First—Transportation of materials. Second—Construction methods.

Transportation includes the handling of the materials from the point of delivery of the common carrier to the site of the work at the point of operation, and upon this alone may depend success or failure, all other conditions being equal.

As to construction methods, only the most modern arrangement of plant, operated at a uniform rate of progress, will insure success.

In order to carry out these fundamentals, one must have the four essentials—*experience, skill, organization* and sufficient *capital,* to properly equip and carry on the work. With these, backed

*Abstract of paper before the New Jersey Highway Association.

†Civil Engineer, Public Service Production Company, Newark, N. J.; President of New Jersey Construction Association.

up with integrity and responsibility, success is assured. If any one of the four is lacking, failure will result and profits disappear.

The new comer into the field of highway contracting usually is one of the following: a contractor experienced in another branch of construction, an individual or bank with money to invest and no knowledge of the business, a former job superintendent who knows nothing but the field construction work, or any combination of these.

The eagerness of capital to participate is shown by the ease with which inexperienced contractors can obtain funds, until his inexperience brings the banker directly into the highway contracting business.

Why is it that keen executives who manage large successful bonding firms of this country do not strike out now and adopt a policy of conservative, sane bonding into which later they are going to be forced?

The ease with which inexperienced contractors can be made "responsible bidders" by the eagerness of the bonding companies to go on their surety has brought about a most unsatisfactory condition that could be avoided if the bonding companies had to do business only through permanently established agents, eliminating the broker that has no place of business.

Bonding companies should adopt a schedule of surety, by which a limit would be placed on the amount of surety the company would assume the first time the applicant applies, for example, up to $60,000; then if the work was completed satisfactorily and the same applicant makes a second request for a bond, the limit should be placed at, let us say, $125,000; after which, if this contract is satisfactorily completed, the bonding company should issue a certificate placing the applicant on the preferred or competitive list, which, providing his financial statement warranted it, would class him as a responsible bidder for highway construction.

UNJUST CONTRACT CONDITIONS

The experienced contractor has to contend with some unreasonable conditions in highway construction and for that reason co-operation with those responsible for the conditions governing the design and supervision of the work should be obtained. For example, in estimating on work, the contractor is required to assume all the elements of chance; for instance, an item for excavation is required to also cover clearing, grubbing, ditching, etc. Again, highway contracting is the only branch of construction industry that has to contend with outside interference at the contractor's expense; I refer to maintaining traffic through the construction, and interference by Public Utilities, especially those with sub-surface structures. It is impossible for the contractor to figure what the conditions above referred to will cost him, yet the requirements of bidding demand that he take care of them.

The requirements for accurate work are more severe on highway construction than in any other branch of the construction industry; for example, in the preparation of sub-grade and setting of forms no variation is allowed, yet frequent field errors occur which the contractor has to absorb and at times are very costly, and even though the sub-grade has been prepared with great care, it is impossible to produce a pavement of the exact thickness and crown as specified. Yet any variation in the thickness of pavement is always at the contractor's expense.

Highway contracting that is confined to about nine months in the year carries a burden more costly than the actual idleness, namely, the loss of an organization, it being necessary to reduce the forces during the inactive season. Due to changes annually in the organization, the abuse of the equipment is excessive and shortens the life of same, which is short enough under favorable conditions. Also the life of the contractor's equipment is shortened by radical changes made from year to year in the design of the highways, thereby requiring new equipment to be purchased and last year's equipment to be scrapped.

The contractor places orders for material to meet the requirements specified, but if it fails to meet the requirements and is rejected, he pays for the loss and delay. Delay from any cause whatever, such as labor troubles, stormy weather, inexperienced inspection, delay in delivery of materials, results in big losses to the contractor inasmuch as all profits on the work were figured at a daily rate of progress.

Anything that can be worked out between the contracting parties to reduce to a minimum the elements of chance will go a long way towards reducing the cost of highways. The time has arrived for all parties interested in the development of modern highways to get together by conference and settle all questions that are involved.

Fundamental Principles of Highway Finance

The following brief statement of the fundamental principles of highway finance is published in the April issue of "Public Roads," the official journal of the Bureau of Public Roads, and therefore presumably represents the opinion of that Bureau on the subject—an opinion concerning the soundness of which there will probably be no dispute by competent authorities.

The wide variation in the present status of highway developments in the several States prevent the adoption of a uniform policy for securing the funds necessary to the annual highway budget and expending these funds. Generally speaking, however, these principles may be enunciated:

(a) States in the initial stage of highway development should issue bonds to defer that portion of the annual charge for construction which would overburden either property or the road user.

(b) States where original construction programs are well under way can, in the main, finance further

expenditure for construction by bond issues devoted to deferring the cost of special projects.

(c) States where original construction is practically completed are concerned chiefly with maintenance and reconstruction and should depend on current funds, save in cases of emergency.

(d) The maintenance of interstate and State roads should be a charge against the road user.

(e) Roads serving a purely local purpose will generally require only light upkeep, and this should properly be a charge against the adjacent property, which in this case is the first and often the only beneficiary.

(f) No road should ever be improved to an extent in excess of its earning capacity. The return to the public in the form of economic transportation is the sole measure of the worth of such improvements.

Comparative Study of Imhoff Tanks*

Operation and results by four plants, and conclusions drawn from the study of the evidence by the author.

By Harrison P. Eddy

OPERATION AND RESULTS

Schenectady. The Schenectady tanks first went into operation in January, 1915, and have never given satisfactory results and have proven very expensive to operate. (Mr. Lewis said that reasonable tank efficiency and inoffensive sludge can be obtained if enough time and money be devoted to it.) They have at times produced great quantities of foam but never during cold weather. Foaming was sometimes decreased by introducing lime into the sludge compartment but at other times increased; and at all times it made the sludge offensive. Hosing the foam sometimes kept it down and sometimes appeared to increase it. The walls of the gas vents were raised in 1916 so that the foam overflowed into the sludge risers and thence to the drains. (At Plainfield the foam, when it flowed into the sludge risers, broke as it passed over the edge and dried and refused to run down the pipe.) In 1922 scum was allowed to accumulate until it extended down to the elevation of the slots and solids escaped through the slots into the sedimentation compartment. When scum was broken up and forced to the bottom, it was possible to remove it as sludge for one or two days, but at the end of three days practically all of the solids again rose into the scum compartment. Mr. Lewis said that when the scum is hosed or paddled, or both, at intervals of two or three days, the solids digest in the normal manner and can be removed as a form of sludge.

Sludge at Schenectady has always been comparatively thin and has not dried well. It has not been offensive during the Summer and early Fall, but during the Winter and early Spring it has been exceedingly so.

The sedimentation efficiency has always been high when not injurously affected by the passage of solids from the digestion to the settling compartments.

Plainfield. The Plainfield tanks have been operated since 1916. They have experienced excessive foaming and large accumulations of scum. During the early years foam overflowed into the sedimentary compartments to the depth of a foot or more and even continued during one winter. No method of the several tried was successful in preventing foaming. In 1910 a Riench-Wurl screen with 1/16-inch slots was installed and the method of operating changed so that three tanks rested while three were in operation, the purpose of this being to secure greater velocity of flow in the sedimentation chambers and thus a better distribution of the sludge throughout the length of the tank. Meantime, digestion could proceed in the other three tanks undisturbed by the entrance of additional solids. These changes materially reduced foaming, although it still is greater than at many other plants. Mr. Downes stated that Dr. Imhoff, during a visit to the plant last year, spoke of this plan as the developing of a great and sensitive organization within the digestion chamber capable of handling a certain amount of organic matter daily but, just as it is about established on this basis, the supply of food is cut off and the organization is starved and disorganized. However, he said that under the local handicap of very poor distribution of solids, this seemed to be the only course open.

Fitchburg. The Fitchburg tanks have been in operation since October, 1914, and have always been free from persistent foaming and excessive scum. In August, 1915, tank No. 1 became very active and foam arose to a height of 4½ feet above the sewage level in the central gas vents, although none occurred in the side vents. Shortly before this, humus-tank sludge* had been introduced into this tank. Sewage was cut off from this tank for about two months and no further trouble developed that year. In June of the following year foam rose 18 inches high in the east vents of the same tank, but drawing of sludge stopped it entirely. In August, 1917, after a week of very hot weather, there was some foaming in another tank, and investigation showed the sludge compartment full to the slot. When sludge was withdrawn the foaming subsided. Only a small amount of scum has ever been removed, none at all in 1922 and about 86 cubic feet in 1923. In this plant it appears possible to prevent foaming by restricting the accumulation of sludge, and to stop it when it does occur by drawing sludge. Fitchburg's sludge has been practically free from objectionable odor and has dried readily.

*Sludge from the secondary tank was pumped into influents to the Imhoff tanks. For three years past this sludge has been pumped into the digestion compartment of one tank, entering 18-in. below the slot.

*Continued from page 114.

Rochester. At Rochester the tanks of the Irondequoit plant have been operated since March, 1917, and have never but once given evidence of foaming. One day five years ago foaming occurred in one tank, but was immediately suppressed by drawing sludge; it "was distinctly a matter of improper operation and occurred when the responsible man in charge was away in the army." The sludge has contained a large percentage of solids, has been free from objectionable odor and has dried rapidly.

Comparison. In the matter of sludge drying, data are not available for accurate comparison. There have been cases at each plant where a 10-inch application of sludge dried in ten days, but in general the beds are filled from six to ten times a year.

Mr. Eddy states that the possible cause of difference in performance of tanks may be grouped under five heads: Character and composition of sewage; temperature of digestion; preparatory treatment of sewage; kind of biological action; tank design; and method of operation. Mr. Lewis believes that in order of importance, so far as relates to Schenectady's experience, tank design would come first, followed in order by temperature, character of sewage, method of operation, preparatory treatment of sewage, and kind of biological action.

Mr. Downes agrees with Mr. Eddy that the conditions essentially unfavorable to Plainfield and Schenectady are: Shallowness; inadequate digestion chamber; impossibility of uniform distribution; large number of compartments; absence of heavy solids; and relatively large proportion of insoluble soaps.

Mr. Eddy's conclusions from this study of the available evidence afforded by these four plants are as follows:

CONCLUSIONS

1. The mineral and heavy, relatively stable organic matter of the combined sewage at Fitchburg and Rochester may tend to prevent excessive scum and foam formation by weighting down the sludge accumulation.

2. Coarse and uncomminuted solids at Schenectady are probably an important factor in the excessive formation of scum.

3. Where the water supply is hard, the insoluble soaps formed constitute a substantial increment in the suspended solids of the sewage and may favor the formation of foam and scum.

4. The variations in the quantity of suspended solids to be removed from different sewages is so wide that the design of the digestion compartment should be based on the quantity of solids to be deposited in it, rather than upon a general assumption of a definite number of cubic feet per capita.

5. Temperature is a factor of fundamental importance in the digestion process.

6. The required capacity of the digestion compartment is governed in large measure by the available temperature and by the duration of the period of low temperature.

7. Difficulties will be minimized by drawing sludge as early in the Spring as inoffensive material can be obtained; by continuing the drawing at a rate sufficient to provide as small an accumulation in the sludge compartment as practicable during hot weather; and by removing, before cold weather, all sludge except that required for seeding.

8. Fine screening, by reducing the quantity of digestible solids to be deposited from the sewage, reduces the load upon the digestion compartment correspondingly, and by removing the coarser matter particularly favorable for scum formation tends to reduce difficulty from that source.

9. Fine screening appears to have been beneficial at Plainfield and Rochester; while not a necessity, it affords a factor of safety in the operation of Imhoff tanks.

10. The advisability of installing fine screens appears to depend upon the relative cost of disposing of the coarser portion of the suspended solids by fine screening on the one hand, and by tank treatment on the other.

11. It is important to distribute the deposited solids as uniformly as possible throughout the digestion compartment; for this reason a relatively short tank is advantageous.

12. Digestion compartments should be subdivided as little as practicable and liberal opportunity should be afforded the sludge to spread uniformly from one end of the tank to the other.

13. Lack of uniform distribution of sludge throughout the digestion compartment may have been an important factor in the unfavorable action at Schenectady and Plainfield.

14. Frequent reversal of flow is necessary to successful operation of multiple compartment tanks.

15. It is important to secure as nearly equal distribution of solids as possible, among the several tanks; failure to accomplish this at Schenectady has been a factor in the difficulty of operation.

16. There appears to be a decided advantage in the greater depth of tanks at Fitchburg and Rochester in preventing excessive scum formation and in providing sludge with a comparatively large proportion of solids.

17. In the design of the digestion compartment, consideration should be given to the probable density and corresponding volume of the sludge as it will lie in the tank.

18. When tanks must be shallow, substantial additional capacity must be provided in the digestion compartments.

19. Taking into account both the load in pounds of deposited solids and the probable density of the sludge, it appears that the digestion compartments at Schenectady and Plainfield are relatively much smaller than at Fitchburg and Rochester, a condition offering one explanation of the difficulties encountered at the former plants.

20. Evidence is so meagre and conflicting, that a final conclusion is not justified regarding the comparative merits of a small and a large proportion of gas vent area.

21. Any opportunity for the breaking up of rising gas-lifted sludge, as by impact upon the floor-partition between the sedimentation and digestion compartments, may be of advantage.

22. Successful operating results depend as much upon intelligence and skill in operation as upon correct design.

23. Complete accurate operating data are highly desirable, and very helpful to intelligent and skillful operation.

24. There is scarcely any knowledge of the kind of organisms, or of the biological action in Imhoff tanks. The absence of such information has made it necessary to confine this study to the structural, physical and chemical differences. They appear to explain many results without consideration of biological action. The latter may have been a factor, possibly as a result of certain structural features, rather than as a primary cause of unfavorable action.

25. The differences in results obtained are not explained by a single condition, but appear to be due to many factors which in the aggregate make a wide difference between the two pairs of plants. The essentially unfavorable conditions at Schenectady and Plainfield are:

Shallowness of tanks;

Inadequate digestion compartments;

Impossibility of uniform distribution of sludge throughout digestion compartments;

Large number of digestion compartments, making it impracticable to determine volume and density of sludge in them and difficult to cope with sludge and scum problems;

Absence of heavy solids from street washings;

Relatively large proportions of insoluble soaps.

NEED FOR RESEARCH

Research is very much needed to procure information upon the following subjects:

1. Temperatures in digestion compartments, preferably determined by automatic recording thermometers.
2. The reaction or hydrogen-ion concentration of sewage, liquid in digestion compartment, sludge, and scum.
3. Variation in quantity and composition of gases evolved under different conditions.
4. Rate and kind of digestion at different temperatures.
5. Kinds and functions of organisms predominating in sludge and scum compartments, respectively, under varying conditions such as different reactions and temperatures.
6. Determination of effect of different depths by operating tanks in exact parallel in all other respects.

Mr. Skinner, in his discussion, gave it as his opinion that the causes of foaming at the various plants are as follows:

SCHENECTADY

Design: Shallow tanks, 8 in line, may be only about ⅜ efficient in digestion and release of gas, hence the loading may be 8/3 as great as indicated by actual capacities.

Small sludge compartments made smaller in effect by poor inter-communication.

Trough bottoms do not lend themselves so well to sludge drawing as hoppers.

Narrow gas vents.

PLAINFIELD

Design: Five tanks in line may be only 3/5 efficient in digestion and release of gas, hence the loading may be 5/3 as great as indicated by actual capacities.

Small sludge compartment made smaller in effect by poor inter-communication.

Narrow gas vents.

FITCHBURG

Design: Tall, narrow scum compartments and gas vents favor air lift action.

Operation: Sludge carried too high.

ROCHESTER

Operation: Sludge carried too high.

Treatment of Dairy Wastes

An investigation into the subject of the effect of dairy wastes upon streams into which they might be discharged, and a study of the methods of treating them were conducted by the Agricultural Experiment Station at Cornell University, Ithaca, N. Y., under the general charge of C. L. Walker, professor of sanitary engineering; various bacteriologists, biologists, chemists and engineers connected with the college being employed in the investigation.

The report, which was published a few weeks ago, gives in detail the methods of conducting the tests and the results. Among the conclusions reached were the following:

The amount of wastes which a stream can satisfactorily dispose of is dependent on (a) the temperature of the stream, (b) the volume of stream flow, (c) the rate of flow, (d) the character of the stream bed and (e) the types of plant and animal life present.

The wastes were broadly classified as fresh milk wastes, buttermilk wastes and wheys from the manufacture of cheese and casein.

Milk wastes may be successfully treated by chemical precipitation with iron sulphate and lime, which produces a clear, non-offensive effluent.

From 75 per cent. to 95 per cent. of the organic nitrogen can be removed from whey by adding a slight excess of lime over that necessary to neutralize acidity, boiling, and then passing the cooled effluent through a septic tank and sand filter. The filter effluent, however, is still two or three times as strong as strong, untreated domestic sewage and must generally be further treated before discharging into a stream.

The activated sludge method is not likely to prove practicable. Settling in an Imhoff tank is not desirable, the effluent being likely to clog filter beds, and the tank being complicated and expensive to construct.

The report recommends the use of a septic tank designed to hold from one to three days' flow of waste, a grit chamber being used to intercept dirt, sawdust, glass and other inorganic matter contained in waste from a dairy plant; the tank effluent being passed through porous beds of sand, stone or other material, at about the rate suitable for domestic sewage. Secondary sedimentation tanks are considered necessary if the filtering material is coarse, although the effluent need not be retained in such tank more than ten minutes.

Garbage Disposal in Indianapolis

Methods Recently Adopted for Dewatering Garbage While Collecting, and for Reducing it to Tankage and Animal Food.

Late developments in the methods and appliances for collecting and disposing of garbage in Indianapolis were described recently before the Indiana Engineering Society by E. W. McCullough, consulting engineer to the Board of Sanitary Engineers of that city.

Garbage from all parts of the sanitary district is collected twice a week from May 1st to November 1st and once a week the rest of the year. A device has been installed in all of the trailers for dewatering the garbage, and when a collector has filled a trailer about one-third full he draws up over a convenient sewer manhole and drains into it the free water. The same process is repeated when the trailer is two-thirds full and again when it is full and ready for connecting up to the train for haulage to the plant.

This dewatering device consists of a perforated plate placed over the entire bottom of the trailer. As the garbage is hauled through the streets it settles down and squeezes out the free water, which settles into a compartment below the false bottom. When the garbage reaches the reduction plant additional water which has been shaken out during hauling is drained off. As much as 150 gallons of free water have been drained from a single trailer, totaling all four drainings. The trailers have a water-level capacity of 3½ yards, but carry a load of 4 tons without spilling garbage along the street, although when 2½ tons were carried without the dewatering device many complaints were received. The construction of the device is such that the water compartment is cleansed at the same time as the remainder of the trailer.

Mr. McCullough believes that it is the free-water content of the garbage that causes the rapid deterioration of the solid portion, and this opinion seems to be confirmed by the fact that, since dewatering, the odors emanating from the receiving station have been greatly reduced and the garbage has a remarkably fresh appearance when dumped into the cooking tanks. Moreover, the products of dewatered garbage are of superior quality.

With the plant now used the garbage is reduced daily within 18 hours from the time it reaches the plant. In summer there is a little greater accumulation, but the capacity of the pit does not permit an accumulation of more than 24 hours.

The present plant contains sixteen Chamberlain digesters, each holding about 4½ tons of green garbage. Twenty-four tank loads is the maximum that can be cooked with any degree of satisfaction in 24 hours. After cooking, the garbage is discharged from the tanks by manual labor and piled in a pit in front of and below the digesters. From the pit the garbage is run through a direct heat drier, thence to a percolator, and finally directly through the direct heat drier again, from which it is transferred to the stock bins. The cooking in the old plant is unsatisfactory. The tankage in the pit often begins to deteriorate before the process can be completed, souring and fermenting very rapidly because it is hot and wet when discharged from the digesters. Another objection is that, in going through the direct heat drier, the tankage is often scorched and burned.

In the new plant an entirely different process will be used. It will continue to be dewatered during collection and will continue to be drained at the receiving station, where the garbage compartment is very large. From this compartment the green garbage will be conveyed mechanically to Morrison reduction tanks, of which there will be thirty-two. The entire process of reduction is performed in these tanks without removing or handling the charge until it has been cooked and dried. Each tank has a capacity of 3½ tons of green garbage, and can treat two charges in 24 hours, cooking and drying every particle of each charge.

After the garbage has entered the tanks, fresh water may be added for cooking purposes. The tank is closed and live steam at about 80 pounds pressure is admitted into direct contact with the garbage for three hours, the tank being vented, and pressure built up to 80 pounds, which it must reach quickly and maintain if the tankage is to be of the best quality. The free water is then decanted as far as possible, after which more may be expelled by admitting steam pressure. The charge is then dried, usually under 15 inches or more of vacuum, by means of a jacket into which the steam is admitted, the charge being meantime agitated and disintegrated. This drying requires about four hours.

The tankage is then discharged into conveyors, which carry it to the preparation house, where it may be degreased by the standard degreasing methods or may be processed mechanically to remove from it needles, pins, glass and similar materials. It is not treated chemically nor ground. The processing removes all of the metallic contents and a very high percentage of the glass and china. Mr. McCullough gave the results of processing ten batches, in which the glass and china in the tankage as discharged from the tank was reduced from quantities varying from 18.6 to 59.6 pounds per ton to amounts varying from a minimum of 1.9 ounces per ton to a maximum of 16.0 ounces per ton.

The tankage is said to have unusual keeping qualities, piles of it stored under most unfavorable conditions for many months having shown no deterioration except some that had been wet by rain.

It is expected that the tankage from the new process can be used for feeding cattle, hogs and poultry. Excellent results were obtained by feeding to a herd of pigs a food containing about 40% of tankage product and 60% grain feed. It has been stated by judges that the condition of animals fattened in this way was in every way equal to No. 1 corn-fed hogs. An Indianapolis poultry fancier and breeder tried some of this tankage and remarked that there was a noticeable increase in egg production within a few days, this test having been made in October, November and December of last year.

Pipe Standardization Conference

A conference has been called by the American Engineering Standards Committee, to be held in Room 1101, Engineering Societies Building, New York, on Thursday, June 5, at 10:30 a. m., to consider the requests of the American Gas Association and the American Society for Testing Materials for the approval by this committee of their respective specifications for cast-iron pipe and special castings.

This conference will consider materials, methods of manufacture, dimensions, pressure ratings and methods of installing pipe and making up joints. Also whether standards should be adopted for flanged pipe, elbows, wyes and other fittings not now included in standard lists, threaded cast-iron pipe, etc. Other related questions also will be considered at this conference.

A Women's Engineering Society

A women's engineering society was founded in England more than four years ago and now has a membership of about two hundred. It held its second international conference recently in Manchester, at which the president stated that present conditions do not encourage women to go into engineering in large numbers for in spite of the very friendly attitude of the large engineering institutions, only a limited number could probably find profitable openings in this profession.

An Historical Report

A remarkable State report has just reached this office. It is the report of the Water Supply Commission of Pennsylvania for the years 1917-1918, printed in 1923. It consists chiefly of stream flow data obtained during those years. Appendix II is a report by Frederic P. Stearns as consulting engineer, dated May 11, 1916, just eight years ago. We hope that copies have been sent to the several historical museums in the state.

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A. PRESCOTT FOLWELL, Editor

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Joint Water Supply Projects

Necessity is bringing about what engineers have so long realized was desirable—the elimination, so far as legally possible, of political boundaries in designing, constructing and operating water works, sewerage and other public utilities. In sewerage we have joint outlets like the Passaic Valley sewer, and joint treatment works like that of the Plainfield-Dunellen plant. Several private water companies serve from two to twenty communities each, but there are not so many instances of publicly owned plants serving a number of communities. The Boston Metropolitan water district is probably the best known of these.

A number of joint projects are now in various stages of consummation, however. One in its initial stages is described in this issue—that proposed for the whole of Westchester county, New York. It would appear that some such scheme must of necessity be put into operation before very many years, since several of the rapidly growing communities of this county are already suffering a water shortage, with no means of supplying the deficiency at a cost that the individual communities find financially practicable.

The same conditions are operating in northern New Jersey to compel joint action for distribution equitably, among the great number of communities, of the limited supply available. A report covering the entire state was prepared about two years ago by a prominent engineer (see PUBLIC WORKS for April 1 and 8, 1922); meantime a supply for an important group of cities and towns in the northern part has been more than half completed—the Wanaque supply, which is being constructed jointly by nine communities, varying in size from Newark with 500,000 population to Glen Ridge with 5,000. For carrying out this project the state has created the North Jersey District Water Supply Commission, which acts as agent for the several communities. The Governor of New Jersey recently urged, what has for years been advocated by many, a commission which will have full power to control the available water supplies of the state and so apportion them among the communities as to most economically and equitably provide for them all.

Another illustration of an effort toward joint action is the conference on traffic problems, to be held May 20, which it is hoped will be attended by mayors and other interested citizens of 411 municipalities within a radius of fifty miles of New York City. This also is to solve a difficulty created or intensified by the same concentration of population that has necessitated solutions of the water problems.

As similar concentration increases around the centers, we will undoubtedly find similar cooperation forced upon the communities affected. The ground water that serves many of the municipalities of Illinois is beginning to prove inadequate to the demand upon it, and the solution in some cases may be found in joint action for developing and distributing surface supplies. The subject is one of increasing importance for water works engineers.

Increasing Main Pressure for Fires

Elsewhere in this issue we discuss the tabulation of data received relative to pressures in water mains, and the fact that a large proportion of the municipalities reporting increase the pressure in their mains at time of fire. We also quote the opinion of an official of an Indiana water company that this practice is highly undesirable. The reasons are stated by him and seem to us to be sound. Experience shows, as might be expected, that a considerable increase in pressure brings to light weak points in the system, and this when breaks, either large or small, are least desirable. Such weaknesses may have occurred since the previous fire, due to electrolysis,

to new services not yet put to the test, or to slow deterioration of pipes or joints.

Fire pumpers would seem to be a much safer and saner method of getting pressure in the hose, as well as probably more economical, than to increase the pressure throughout many miles of mains in order to use it at one point only.

Municipal Bonds

State, county and city bonds continue to be sold quite generally throughout the country, and the record for bond sales, according to the "Daily Bond Buyer," indicates that borrowing for public improvements such as roads, sewerage, waterworks, irrigation, etc., for the first quarter of 1924 is in excess of the first quarter of 1923 and nearly as great as that of the maximum year of 1922. Apparently local government authorities are still somewhat behind on construction programs; but another reason for maintaining the present rate of issuing bonds is that the costs are still much higher than before the war and a larger amount of bonds is necessary to pay for an equivalent amount of work.

The sale of municipal bonds for March totalled $88,241,260, while the total for the first three months of the year has been $265,051,876. It appears, therefore, that the sales during March are practically one-third of the total for the quarter, or that the rate continues about the same.

One reason for thinking that municipalities will no longer defer important work is that it seems to be generally understood that there will be no early reduction in cost of work or at least that such reduction will be comparatively small. One reason for this is that there does not seem to be any present indication of reduction in wages, especially those of skilled and semi-skilled labor, much of this having within the past few months arranged wage contracts for a period of two years.

Drought of 1923

The summer and early fall of 1923 was a dry period in many parts of Connecticut, and some waterworks superintendents thought it must be as severe as any on record. This phase of the matter was investigated by the Connecticut State Department of Health, and the result, as published in the Bulletin of the Department for March, was the decision that this was by no means the severest drought on record.

Rainfall records were obtained from New Haven, Bridgeport, New London, Middletown, Thompson, Cornwall, Hartford and Mansfield. The New Haven record covers seventy-three years, from 1804 to 1829 and continuously from 1873 to date. The Middletown records are continuous from September, 1858, to date. Those for Hartford and New London cover a period of fifty years, but the remaining four stations extend over a much shorter period.

The driest part of 1923 was the four months from June to September. The records of the various cities show that simliar periods were drier than this twice in the records of New Haven, four times at New London, eight times at Middletown, ten times at Cornwall, twelve times at Thompson, twenty-seven times at Mansfield and thirty-one times at Hartford.

Following September there was considerable rain, and if the six months' period from June to November (which is taken in Connecticut as the dry period of the year) be considered, it is found that drier periods covering the same months had occurred five times at Cornwall, eleven at Bridgeport, seventeen at New Haven, nineteen at New London, twenty-three at Middletown and Thompson, twenty-five at Mansfield and thirty-nine at Hartford.

Considering the whole year of 1923, the rainfall was well above the previous dry record of each of the stations, and, in fact, was little below the average annual rainfall at any of the stations and was greater than the average at some of them.

The records for last year showed that the drought was felt mainly in localities close to the sea.

The special point made by the Board of Health was that waterworks officials who found their supply bordering on the inadequate last year should not comfort themselves with the idea that this was an unusual drought not likely to occur again; but, since several drier years and even drier 4-month periods have been experienced in the past, they are likely to occur again and should be provided against.

Novel Standpipe Building

A novel method of building a standpipe was employed last year by the Chicago Bridge & Iron Works in constructing two standpipes at Dallas, Tex. The standpipes were 60 feet in diameter and 100 feet high. A large portion of the plates in these standpipes were so heavy that they could not be hoisted into plate buggies and moved in the customary manner. Conditions seemed to demand some form of derrick capable of easily hoisting and handling these heavy plates. The cost of a specially-built derrick of the proper dimensions, to be shipped to this work for this one job and then removed, was prohibitive.

Each standpipe was to be covered with a conical steel roof supported by twenty-four radial trusses. It occurred to someone on the job to use these trusses in constructing the desired derrick, and this was actually done. Sixteen trusses were used to build a mast 130 feet high and 8 feet square, four of the trusses being stood on end to make the four sides of each of the four sections of the mast. Two other trusses were so joined together as to make a boom 35 feet long. The mast was located out of center of the tank and the six remaining trusses were raised and placed in final position before dismantling the derrick. The derrick was operated in the usual manner, with double-drum engine and swinging gear. The hoisting cables led to the bottom of the derrick and out to the engine through small holes drilled in the bottom ring. Adolph Eastman, superintendent in charge of the work, reported that the entire scheme worked out very satisfactorily.

Day Labor on New York State Highways

The Highway Department of New York State does not advocate heavy reconstruction by departmental forces, finding that little can be saved thereby in cost and feeling that such work should not be taken from contractors who are equipped for it and expect to be allowed to bid on it.

There are instances, however, when reconstruction by departmental forces is believed to be to the best interest of the State. Many times small sections of less than a mile on important routes break up in the spring. It is not always desirable or economical to repair them by the ordinary methods, but it is vitally necessary that they be rebuilt in the shortest possible time. To prepare and advertise plans requires at least two weeks. Another four weeks are consumed in the advertising and execution of the contract. Where the State is equipped for this work, the reconstruction can be well along or even finished in that length of time.

There are also many roads of secondary importance in each county, which, because of lack of funds, the State is unable to reconstruct. Due to the system of appropriating money by counties, which can be used only in the county for which it is appropriated, there is not enough left after that needed for general maintenance has been deducted to provide for a fair-sized contract. It has been the practice in such cases for the county engineers to organize a special gang and reconstruct as much of the road as his funds will permit. In this way it is possible each year to improve a considerable mileage of bad road which would not be possible were it necessary to do these short stretches by contract, as a contractor's overhead would be unreasonably high for the size of the project.

Water District for Westchester County

Plan proposed for meeting present and future shortage of many of New York's suburbs by means of a board or commission with power to acquire supplies and condemn lands and sell water to communities needing it.

Westchester County, New York, lies immediately north of New York City and a considerable part of its population are in business in that city. The county has consequently increased in population rapidly through the influence of metropolitan growth. It lies between the broad and deep Hudson river on the west, Long Island Sound on the south and the state of Connecticut on the east; while the northern part of the county is very largely occupied by the Croton watershed, which supplies part of the water used by New York City.

It is apparent from this that the problem of supplying water to this large and rapidly increasing population is almost sure to become a very serious one. The only available sources of supply outside of its own area would appear to be those in the state of Connecticut and those north of the Croton watershed. It is probable that Connecticut would not permit diversion of water from its own sheds into another state. To bring water from above the Croton shed would mean a rather long conduit, but this would not be prohibitively expensive, although it is to be avoided if a satisfactory supply can be found nearer at hand.

As a matter of fact, many of the communities in this county have already found difficulty in obtaining sufficient water for their inhabitants and several of them are purchasing water from New York City, this supply being obtained from New York's aqueduct, which passes through or near them.

Because of this condition, the Board of Supervisors of Westchester County in November, 1922, employed Nicholas S. Hill, Jr., to study the problem and advise them as to what plans could be taken for meeting this condition. His report has recently been received and published by the Board. In this report Mr. Hill recommends the creation of a board or commission which would acquire such existing water plants and sources of supply as might seem desirable, acquire additional supplies and watersheds, and sell at wholesale to individual communities in the county such amounts of water as they might need to supplement their existing supplies, these communities to distribute the supply to the consumers.

"A few of the communities own and control sources of supply which are measurably adequate under ordinary conditions. A few own and control sources which are entirely inadequate and which they supplement by taking water from the city aqueducts. One or two have recently acquired the distribution system within their corporate limits and propose to secure water entirely from the city aqueducts. Others derive their water from private water companies, the demands upon which have entirely outgrown their present capacity. The water supply of some communities is unsatisfactory, not only as to quantity, but as to quality."

"The local situation is such that no single municipality or water company can hope to unscramble it. The smaller places may eke out with a precarious supply for several years to come, but the larger places must be helped at once. . . . The solution of the problem can only be reached by joint action on the part of all of the communities in the county through the agency of a commission appointed for the purpose of solving it."

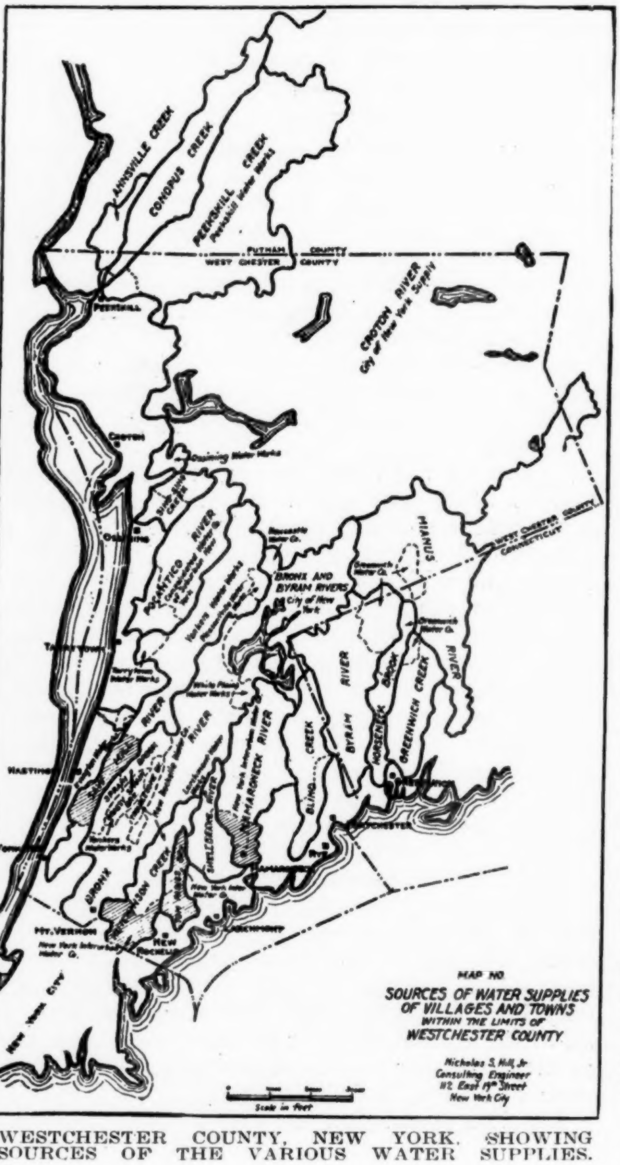
Mr. Hill found that the safe yield of the now

developed sources in the county is 23,500,000 gallons per day, while the consumption in 1922 totalled 32 million gallons. The condition is even worse than this indicates, however, for Peekskill controls more of the available supply than it consumes, leaving the balance of the county with a shortage of nearly 12 million gallons a day.

An estimate of future population was made, and the conclusion reached that by 1950 the county will have a population of 800,000 with a water consumption of 107 million gallons a day, or more than 4½ times the safe yield of the sources now developed.

Of the total water supplied, nearly 90% is from surface sources, and it is not considered that underground sources are sufficiently promising to be considered in the development of the county's supply.

It was believed that two plans were open for increasing the supply; one, developing the adjacent local watersheds within the county and in dry years reinforce these with New York City water, or supplement them by going to more remote sources. New York's water at present is being sold at $133 per million gallons at the aqueduct and in most instances has to be pumped, which brings the cost to $150 or even $180 delivered into the distribution system.



WESTCHESTER COUNTY, NEW YORK, SHOWING SOURCES OF THE VARIOUS WATER SUPPLIES.

The other plan is to go directly to the watersheds north of the Croton basin, which include those of Peekskill Hollow Creek and its tributaries, which creek is now being used by the city of Peekskill for its supply.

COMPARISON OF LOCAL AND REMOTE SOURCES

The former plan would leave intact the present developed sources of the several communities except where they can be further developed to increase the supply, supplementing each by water from other sources either within the county or from the New York aqueduct. It is estimated that, if properly developed, these local watersheds would yield a total of 48,850,000 gallons a day, or nearly double the present consumption, and this supply would therefore probably serve the needs of the county for fifteen or twenty years to come. drawing no considerable quantity from New York City except at long intervals.

By proper development, two of these supplies could be made to yield double the amount now furnished, another supply could be increased 2.6 times, and others could be increased more or less.

One of the difficulties in developing adjacent sources is found in the considerable part of the areas of some of the watersheds that are occupied by villages and lager communities. Moreover, this difficulty will naturally and materially increase with the increase in population and extension of the area occupied by it. Even if settlement upon the watersheds is prevented by the acquiring of them by the commission, the demands for land would so increase the value of this property that it might before very long be more economical to sell the watersheds for this purpose and obtain the supply from a considerable distance to the north of the county.

Considering the development of remote sources, Mr. Hill refers to the Burr-Hering-Freeman report for additional water supply for New York City made a number of years ago, wherein the engineers considered the development of Fishkill creek, Wappingers creek and the Roliff Jansen Kill. These engineers did not consider Peekskill Hollow creek, because it would furnish only a very small amount of the requirement of New York. For Westchester County, however, it is recommended that the remote sources be developed in succession beginning with Peekskill Hollow creek and Fishkill creek, passing then to Wappingers creek and finally Roeliff Jansen Kill. The first of these is estimated to yield 50 million gallons per day with pumping, the second 50 million, the third 90 million and the fourth 115 million.

In comparing the development of the remote as compared to local sources, consideration was

given to the speed with which the present insufficiency of supply could be obviated; the relative cost, balancing not only first cost but also operating expenses, including the maintenance of conduits, aqueducts and reservoirs, pumping and distribution, etc.; and third the rate of amortization which would have to be applied in order to provide against the possibility of having to supersede or discard the local sources at an early date. The third point involves the possibility of increase in value of the land on the watersheds, of pollution of the water by settlements crowding against the borders of the watersheds, and the fact that they will be outgrown within a very few years. This would mean that the rate of amortization for the local sources would necessarily be very high. The report, being only a general and preliminary one, does not attempt to settle this question, which could be determined adequately only by making a careful analysis of the costs of the various developments considered.

(To be continued)

Main Extension Charges in Gary

In Gary, Ind., the water company makes extensions to the watermains where there is a reasonable demand, but investigations have disclosed the fact that in a number of recent instances there was not at once sufficient new business available along the proposed lines to yield an income of 10 per cent. on the cost. In such cases the owners of a subdivision or of a large piece or pieces of property desiring water connections make a contract with the water company, agreeing to pay the difference between 10 per cent. of the cost on the new construction, and the entire gross revenue received by the water company from takers of water through the new extension, until such time as the gross revenue equals 10 per cent. Any revenue that may be received from the city for rental of hydrants connected to the extension is credited to the 10 per cent.

Haverhill Waterworks Notes

In his report for 1923, Herbert C. Crowell, superintendent of the Haverhill, Mass., waterworks, reports that during that year, although the Board had arranged for laying considerable length of mains, the price of pipe was and remained so high that only a small part of the work voted was actually performed, this including such extensions as were necessary to supply new houses on streets already having water, and several short extensions to eliminate dead ends.

Following the recommendation of the National Board of Fire Underwriters, two chemical extinguishers were placed in each of the three pumping stations and a line of 1-inch hose was installed in the two stations that were not so equipped.

As for several years past, a man was constantly employed in cutting off the vegetable growth and underbrush along the shores of the two reservoirs, which not only maintained a better condition of the water, but also added to the general appearance. Four thousand Scotch pine and 1,000 Norway spruce were purchased from the State Forestry Department and set out during the Spring on the watershed. During the year water was shut off from seven services for non-payment, which appears to have been effective, as Mr. Crowell reports only one water bill remaining unpaid at the end of the year.

Pressure in Water Mains

Maximum and minimum pressures, both in regular service and special for fires, in the distribution systems of about six hundred cities.

One of the tables prepared from the questionnaire answered for us by superintendents of more than 650 waterworks plants has to do with the maximum and minimum pressures in the mains of the various cities and the amount by which these pressures are increased in case of fire. Also the use of fire engines for supplementing the pressure in the watermains. We have combined these figures by states and obtained the average maximum pressure and the average minimum pressure for each of the states, with the results shown in the accompanying table.

It is noted that for the majority of states there is considerable uniformity as to the average maximum pressure, with considerably less uniformity as to the average minimum pressure occurring at high points in the various cities. The range between the high and low pressure in any one city is, of course, dependent upon the topography of the city (except where there are two or more separate distribution systems, each with its own pressure).

MAXIMUM AND MINIMUM PRESSURES IN WATER MAINS

Averages by States

State.	Max.	Min.	State.	Max.	Min.	State.	Max.	Min
Alabama	84	61	Louisiana	44	35	Ohio	89	52
Arizona	78	50	Maine	101	57	Oklahoma	67	44
Arkansas	81	62	Massachusetts	109	45	Pennsylvania	101	48
California	63	37	Michigan	69	48	Rhode Island	113	52
Colorado	100	45	Minnesota	69	53	South Carolina	71	46
Connecticut	89	45	Mississippi	76	38	Tennessee	77	48
Florida	73	40	Missouri	76	42	Texas	63	41
Georgia	66	51	Montana	77	56	Utah	97	67
Idaho	72	52	Nebraska	58	36	Vermont	141	67
Illinois	61	38	New Hampshire	120	49	Virginia	82	28
Indiana	66	50	New Jersey	79	45	Washington	98	35
Iowa	78	48	New York	94	53	West Virginia	117	61
Kansas	67	51	North Carolina	74	54	Wisconsin	60	47
Kentucky	75	56	North Dakota	62	43			

We find that the only states in which the average maximum exceeds 85 pounds are the six New England states and Colorado, New York, Ohio, Pennsylvania, Utah, Washington and West Virginia. Except for Ohio, New York and possibly Pennsylvania, each of these may be considered a distinctly mountainous state, and the high pressure is probably due to opportunities for location of reservoirs at high points above the cities.

In the flat states, where pressure must be due entirely to that contributed by pumps, the variation is considerable, the minimum being 44 pounds in Louisiana, while Ohio's 89 pounds average is apparently the maximum for the non-mountainous states.

Maximums for individual cities run considerably above the state averages, of course. We find 47 maximums exceeding 125 pounds, the majority of these being not over 150, although four are 175 and one is reported at 220.

The state averages of minimum pressures range from 28 pounds in Virginia to 67 in Utah and Vermont, the majority of them lying between 40 and 60. These bear no relation to the maximum pressures. In fact, some of the lowest pressures are found coupled with the highest, as in the case of Virginia with an average minimum of 28 pounds and an average maximum of 82, and Washington with an average minimum of 35 and a maximum of 98. This is readily explained by the fact that, as the mountainous states furnish the highest pressures, they also furnish the greatest extremes in topography, and thus the greatest differences between the high and low pressures in the same city.

Examining the individual cities, we find 36 with pressures less than 25 pounds, four reporting pressures running as low as 10 pounds.

FIRE PRESSURES

Several of the cities do not report whether or not they increase the pressure in the mains in case of fire, but 251 report such increase in pressure and 231 report that no increase is made; and from the other information given it seems to be justifiable to assume that very nearly 50% provide increased fire pressure and 50% do not.

The amount of increase in pressure reported varies all the way from 5 pounds to 140 pounds, the majority, however, not increasing over 50 pounds. Only twelve cities report an increase of more than 100 pounds and only two more than 125 pounds.

The effect upon the distribution system and house plumbing of these considerable increases in pressure, from 30 to 175 pounds in one city, from 40 to 125 in another and from 45 to 140 in a third, would seem to be a matter of great importance when we consider the serious effects upon fire fighting should the sudden increase in pressure cause a general giving-way of plumbing fixtures and weak service pipes and mains.

The majority of the cities report the use of fire engines for boosting the pressure as furnished by the watermains, most of these stating or implying that the engines are used only in the higher sections of the city where the pressure is low or in the business section where the risk is extra great, several stating definitely that this is the case. Many of those that use fire engines also increase the pressure in the mains during fires.

Two hundred of the cities, however, report that they do not use fire engines but rely entirely on pressure in the mains. In the great majority of these cities the minimum pressure during fires (either under ordinary conditions or after the additional fire pressure has been added, where this is done) is above 50 pounds. Only 28 cities report a pressure lower than this, and of these, 12 have a miminum of 40 pounds or more, 13 of 30 or more but under 40, while one reports a minimum of 26 pounds and one 25 pounds. It is presumed that these low pressures are found only in some high section of the city containing comparatively few buildings, and these residences where the fire risk is not great.

Increasing Pressure for Fires

The vice-president of the Gary (Ind.) Heat, Light & Water Co. takes pride in the fact that his company, in case of fire, doubles the pressure in the mains in 15 seconds after the alarm sounds and holds it at 100 lbs. or more. But, just the same, he does not believe in the practice, considering it a perilous one, which may cause a catastrophe at any time in Gary, as it has in many cities. His opinion was given as follows, in a paper before the Indiana Sanitary and Water Supply Association:

It is common knowledge that any structure is most apt to fall or break when subjected to the greatest strain. Then remember in many cities and towns the water pressure is greatly increased very frequently, thus producing severe and numerous strains throughout the entire distribution system because a fire alarm is sounded. This crude method is appreciated when statistics prove a very large percentage of such alarms are false, and that a great many fires are extinguished in their incipiency by the use of chemicals, or could be put out by comparatively small quantities of water available at normal pressures, so that in the great majority of instances when the high pressure is applied for fire purposes, it actually serves no useful purpose, but really weakens the general water system. Then, to cap the climax, we are so illogical as to actually stage practically all of these breaking and failure tests at such times and on such occasions when human life is at stake and property threatened with destruction. Serious failures and breaks naturally occur under such stressed conditions, lives are sometimes sacrified, property losses are enormous and the story is repeated. Such folly seems incomparable.

It is almost criminal to continue such antiquated, hazardous practices in any town or city of considerable size, that so places its entire water supply in jeopardy when invariably much better service is insured in a safe and sane modern method by using portable pumpers.

Insofar as public protection service is concerned, whatever pressure is required to extinguish fires, in excess of that ordinarily furnished for general use, I believe should be supplied by portable pumpers operated by city fire departments. I believe the universal use of such pumpers is bound to follow sooner or later, and consider water departments in those cities and towns where the normal pressure is say, not to exceed 60 pounds, and the pressure is naturally increased during fires, would make a wise investment when in the purchase of all public fire hydrants hereinafter to be installed, that they be equipped with steamer connections, in addition to the usual two-way openings, etc., also the distribution mains and hydrant connections should be designed to conform thereto, all in accordance with the specifications of the National Board of Fire Underwriters. This would greatly facilitate matters so that when the change over was put into effect, much progress toward that end would already be made.

Water Works Statistics

Tabulated From Questionnaires Filled out by Nearly Seven Hundred Water Works Officials—Mains Laid Last Year; Pressures in Mains, Both Regular and for Fire Service; and Pumping Plants, With Recent Changes Made in Type of Plant

The questionnaire sent out by PUBLIC WORKS this year, following our long-established practice, has been answered by nearly seven hundred superintendents and other officials of water works plants, and the replies have been tabulated in the tables which will be found on the following pages. Certain features of the information given concerning pumping plants and pressures in mains are discussed elsewhere in this issue.

The questions to which these items of information were given in reply were as follows:

Street Mains: "What length did you lay in 1923 of cast-iron mains under 6″ diameter?" "of 6″, 8″, 10″ and 12″ diameter?" "larger than 12″ diameter?" "What length did you lay in 1923 of steel pipe 12″ diameter or smaller?" "What length of larger than 12″ diameter?" "What other kinds of water pipe did you lay, and how much of each?"

Pumping: "What kind of pumping plant have you in regular service (steam, electric, gasoline, oil, etc.)?" "What kind in reserve?" "What change have you made (as from steam to electric or to gasoline) during the past five years?"

Pressure: "Is pressure in the mains relied on for fire service, or are fire engines used?" "Under ordinary conditions, what is the maximum pressure in the mains?" "What is the minimum pressure?" "How much is the pressure in the mains increased by the pumps during fires?"

Some of those replying to the first set of questions gave lengths of services laid as well as of street mains, and it is possible that some of the lengths of pipe 2 inches and less in diameter entered in the table were services, although we endeavored to eliminate all such where it was evident that they were not street mains. A number explained that these small mains were intended to be temporary only, and probably this was the case in the majority of instances.

Under the head of pressure in mains, it seems probable that some gave the pressure at the pumping station and not that at the lowest and highest points of the distribution system, as was intended. Some in reply to the last question apparently overlooked the words "in the mains," and gave the pressure in the hose created by the fire pumpers. Where this was stated or evident, the figure was of course not entered in the table, but there may be some of the maximum pressure figures entered in the table that refer to such pressure.

STREET MAINS LAID IN 1923

City	Cast Iron Mains: Under 6″	Cast Iron Mains: 6″, 8″, 10″ & 12″	Cast Iron Mains: Larger than 12″	Steel Pipe: 12″ or smaller	Steel Pipe: Larger than 12″	Other kinds	Size	Length, Ft.
Alabama:								
Athens	1,000	None	None	None	None	......	2-in 1-in	3,000 2,000
Gadsden	0	1,000 6-in.	250	None	None	None	......	......
Mobile	None	6,654	......	None	......	......	......	27,000
Opelika	1,800	500	......	......	......	......	......	......
Talladega	None	3 mi.	4 mi.	None	None	None	......	......
Troy	3,000 4-in.	5,000 6-in.	None	None	None	None	......	......
Arizona:								
Douglas	8,000	None	None	None	None	......	......	......
Glendale	None	None	None	1,200	None	......	......	......
Prescott	144	4,139 6-in. 1,396 8-in. 1,342 10-in	None	None	None	......	......	......
Arkansas:								
Harrison	None	None	None	......	......	......	......	......
Russellville	3 mi. 4-in.	......	......	......	......	None	......	......
Texarkana	None	62,614	None	None	None	None	......	......
Van Buren	2 mi.	4½ mi.	None	1 mi.	None	None	......	......
California:								
Alhambra	54,974 4-in.	25,497	7,232	......	......	......	......	......
Anaheim	6,000 4-in.	4,000 6″ 1,530 10″	......	......	......	St'd. screw	2-in.	34,000
Carmel, Monterey, Pacific Grove & Pebble Beach	22,814	3,582	......	......	......	......	......	......
Dinuba	......	......	......	7,000	......	......	......	......
Fullerton	30,000 4-in.	1,800 6-in.	None	None	None	None	......	......
Inglewood	23,094	18,364	......	38,915	3,245	......	......	......
Madero	None	......	......	2,000 3-in.	......	Riveted steel	4-in.	2,000
Marysville	400 3-in. 2,000 4-in.	......	......	......	......	......	......	......
Modesto	None	384	None	None	None	Galv. iron	2-in.	2,229
Monterey Park	60,000	None	......	......	......	......	2-in.	Ap. 5,000
National City	4,578	3,800	......	......	4,535	Rein. conc. Mathe'n tube Screw casing Std. screw	......	2,484 5,126 6,928 30,443
Oxnard	2,886 4-in.	......	......	1,500 3-in.	......	......	......	......
Palo Alto	10,690	180	None	3,719 2-in.	None	None	......	......

STREET MAINS LAID IN 1923

City	Cast Iron Mains: Under 6"	Cast Iron Mains: 6", 8", 10" & 12"	Cast Iron Mains: Larger than 12"	Steel Pipe: 12" or smaller	Steel Pipe: Larger than 12"	Other kinds	Size	Length, Ft.
California (Continued)								
Redlands	None	None	......	......	3,000 20" 6,000 24" 7,000 28"	......	......	......
Riverside	......	......	......	......	......	Black dipped Matheson Matheson Matheson Riveted steel	2-in. 4-in. 8-in. 6-in. 12-in.	4,000 6,500 2,600 350 450
Salinas	2,663	2,009	None	None	None	Galv.	2-in.	4,745
Santa Barbara	8,653	30,134	3,166	None	None	......	......	......
South Pasadena	3,300 4-in.	......	......	2,800 4-in.	1,600 16-in.	Casing	4-in.	2,100
Upland	None	None	None	None	None	......	4-in.	1,726
Visalia	None	None	None	None	None	Std. screw	4 & 6-in.	......
Woodland	None	......	None	None	None	Galv.	2-in.	1,200
Colorado:								
Colorado Springs	2,100 4-in.	9,391	None	None	None	None	......	......
Delta	None	......	......	1,100 2-in.	......	......	......	......
Connecticut:								
Ansonia	None	867	1,088	None	None	......	......	......
Bridgeport	830 4-in.	1,661 6" 19,484 8" 1,247 10"	None	None	None	None	......	......
East Hartford	5,000 4-in.	500 6" 300 8" 500 10"	......	......	......	Galv. steel	1½ & 2-in.	2,000
Putnam	None	1,200	None	None	None	None	......	......
Southington	536	617	None	None	None	......	......	......
Torrington	106	298	None	None	None	......	......	......
Westport	2,540	3,633 6" 1,550 8"	......	......	......	......	......	......
Willimantic	......	2,500 6-in.	......	......	None	......	......	......
Florida:								
Fernandina	......	1,200 6-in.	......	......	......	......	......	......
Plant City	800	7,000	......	None	None	Galv.	1½ in. 2-in.	6,000 25,000
Georgia:								
Bainbridge	1,800	2,000	None	None	None	......	......	......
Cedartown	None	None	None	None	None	Galv.	1 & 2-in.	......
Decatur	......	7,804 6-in.	None	None	None	......	......	10,000
Eatonton	None	None	......	......	......	......	......	......
Elberton	......	2,000	None	None	None	......	......	......
Griffin	None	3,500	......	......	......	None	......	......
La Grange	5,600	12,500	......	......	......	......	......	......
Thornton	......	500 6-in.	......	......	......	......	1½-in.	4,500
Thomasville	None	2,000	......	......	......	......	......	......
Waynesboro	2,000	2,600	None	None	None	None	......	......
Idaho:								
Boise	None	None	None	9,197	None	Galv.	2" & under	22,476
Burley	......	......	......	......	......	Redwood	4-in.	1,000
Coeur d'Alene	None	......	......	......	......	Wood	10 to 20" 4 & 6"	5,000 5,000
Lewiston	None	None	None	2,070	......	None	......	......
Montpelier	None	None	None	6,000 5-in.	None	......	......	......
Weiser	None	None	None	None	None	......	......	......
Illinois:								
Bloomington	None	4,000	......	......	......	None	......	......
Cicero	......	3,8[illegible]	......	......	......	......	......	......
Elmhurst	15,000	15,000	None	None	None	None	......	......
Freeport	1,000 2-in.	600 6-in.	None	None	None	None	......	......
Galesburg	2,696	None	None	None	None	None	......	......
Geneva	None	None	None	None	......	......	......	......
Hinsdale	None	42,000	......	None	None	None	......	......
Hoopeston	None	......	None	......	......	......	2-in.	400
Lake Forest	600	......	300 16-in.	None	None	......	......	......
Lincoln	None	371 6-in.	None	None	None	Wrought iron	2-in. 1½-in.	2,031 40
Mattoon	800	300 12-in.	None	None	None	None	......	......
Morrison	1,300 4-in.	......	......	......	......	......	......	......
Nokomis	None	4,000 8-in.	None	None	None	......	......	......
Oak Park	None	2 mi.	¼ mi.	None	None	......	......	......
Peru	600	None	......	......	......	......	......	......
Princeton	None	None	None	None	None	......	......	......
Quincy	1,173	11,752	None	None	None	None	......	......
Rockford	None	24,000	2,000	None	None	None	......	......
Rock Island	......	13,710	......	......	......	......	......	......
Silvis	500 4-in.	None	None	None	None	None	......	......
Springfield	None	16,504	935 16-in.	None	None	None	......	......
Waukegan	......	5,000 6-in.	None	None	None	None	......	......
Indiana:								
Columbia City	1,910 4-in.	......	......	682 2-in.	......	......	......	......
Connersville	240 4-in.	None	None	None	None	None	......	......
Crawfordsville	None	10,000 6-in.	None	500 2-in.	None	None	......	......
Evansville	None	19,233	......	None	2,700 30-in.	Byers galv.	2-in. 2½-in. 3-in.	25,861 2,600 2,814
Fort Wayne	7 mi.	......	......	......	......	......	......	......
Gary	None	None	......	18,000	None	None	......	......
Huntington	3,780 4-in.	1,525 6-in.	None	None	None	......	......	......
Lafayette	4,086	1,879 6-in.	......	None	None	......	......	......
La Porte	1,050	132	19,891	None	None	None	......	......
Linton	......	800 6-in.	......	......	......	Gal. steel	2, 1½, 1¼"	3,000
Mishawaka	......	16,000 6-in., 8-in. & 10-in.	None	......	None	None	......	......
Nappanee	......	......	......	......	......	Gal.	2-in.	1,800
New Albany	None	6,000	None	None	None	......	2. 1½, 1¾"	10,000
Newcastle	2,400	400 6-in. 800 10-in. 300 8-in.	None	None	None	Gal. iron	¾" to 2"	3,000
Richmond	362	6,394	......	......	......	......	......	......
Rushville	......	3,000 6-in.	None	None	None	None	None	......
Seymour	None	1,600 8 10 12	None	......	None	......	......	......
Shelbyville	300 4-in.	None	None	......	......	Galv.	2-in.	600
South Bend	300	42,858	5,466	None	None	None	......	......
West Lafayette	None	1,650 6-in.	......	......	......	......	......	......

STREET MAINS LAID IN 1923

City	Cast Iron Mains: Under 6"	Cast Iron Mains: 6", 8", 10" & 12"	Cast Iron Mains: Larger than 12"	Steel Pipe: 12" or smaller	Steel Pipe: Larger than 12"	Other kinds	Size	Length, Ft.
Iowa:								
Ames	10,000	2,500	......	None	None	None	......	......
Belle Plaine	600	None	5,738	......	......	......	......	......
Burlington	592	5,232 6-in. 4,172 8-in. 1,632 10-in.	None	None	None	......	......	......
Cedar Rapids	271	27,833	......	None	None	None	......	......
Charles City	½ mi. 4-6"	......	None	None	None	None	......	......
Council Bluffs	None	12,698 6" 3,178 8-in. 5,821 10"	......	6,028	None	None	......	......
Des Moines	None	57,725	None	None	None	None	......	......
Dubuque	1,086 4-in.	28,458 6" 7,567 8-in.		8,979 10 in. 6,820 12-in.	......	......	......	......
Fort Dodge	415 4-in.	7,838 6-in.	......	......	......	......	......	......
Fort Madison	None	500 12-in.	None	None	None	None	......	......
Indianola	¾ mi.	......	......	......	......	......	......	......
Iowa Falls	......	400	None	......	......	None	......	......
Marshalltown	None	3,544 6-in. 80 12-in.	None	None	None	None	......	......
Mason City	......	2 mi. 6-in.	......	None	None	None	......	......
Mt. Pleasant	2,000	None	None	......	......	None	......	......
Muscatine	1,000 2-in.	1,000 6-in. 500 10-in.	3,000 16 in.	1,000 2-in.	......	......	......	......
Newton	4,000	......	......	......	......	......	......	......
Sioux City	......	......	2,684	......	......	......	......	......
Vinton	1,375	None	None	None	......	None	......	......
Kansas:								
Augusta	2,200 2½" 3,000 4-in.	......	......	......	......	......	......	......
Council Grove	450	None	None	None	None	None	......	......
Dodge City	20,000	1,400	......	......	......	......	......	......
Fredonia	700	None	None	None	None	None	......	......
Galena	None	None	None	3,800 2-in.	......	......	......	......
Garden City	5,000	None	None	None	None	None	......	......
Hiawatha	400	None	None	None	None	None	......	......
Humboldt	None	None	None	None	None	W. I.	2-in.	2,000
Hutchinson	......	10,048 6" 550 8"	None	None	None	None	......	......
Independence	......	½ mi.	None	None	None	......	2-in.	1 mi.
Osawatomie	5,500 2 & 4"	None	None	None	None	None	......	......
Ottawa	3,600	1,300	......	None	......	......	......	......
Pittsburg	9,228 4-in.	2,274 6-in.	......	......	......	W. I.	2-in.	6,177
Pratt	1,200 4-in.	......	......	......	......	......	......	......
Salina	342	12,403	None	None	None	None	......	......
Kentucky:								
Bellevue Dayton Fort Thomas	2,500	8,900	None	Sev. mi.	None	None	......	......
Covington	100 4-in.	......	None	None	......	......	1-in. 4-in. 6-in.	200 100 3,000
Glasgow	None	None	None	None	None	......	1¼-in.	600
Hopkinsville	None	960	None	None	None	Galv.	3-4-in. 1-in. 2-in.	161 202 1,834
Jenkins	6,000 4-in. -	......	......	......	......	Galv.	2-in. 1½-in. 1¼-in. 1-in	926 514 1,000 2,537
Lexington	8,500	14,000	......	None	......	None	......	......
Louisville	1,500 4-in.	79,604	28,217 20" 2,831 48"	None	None	None	......	......
Mayfield	5,000	......	......	......	......	......	2-in.	4,000
Pineville	500	800 6-in	......	None	None	None	......	......
Richmond	2,000	......	None	......	......	......	6-in.	3,000
Louisiana:								
Alexandria	6,450	14 772	None	None	......	......	......	......
Covington	17,150	18,500 6-8 in.	None	None	......	Galv.	2-in.	23,000
Crowley	460 4-in.	......	......	......	......	......	......	......
Leesville	¼ mi.	None	None	1 mi.	None	......	......	......
Mansfield	340 4-in.	1,500 6-in. 300 8-in.	None	None	None	......	......	......
Rayne	......	18,500 6-in. 767 8-in.	None	......	......	......	......	......
Maine								
Bangor	......	1,424 6-in.	......	......	......	......	......	......
Calais	350	None	None	None	None	......	2-in.	350
Rockland Camden Thomaston Rockport	None	800 8-in.	......	......	......	......	......	......
Caribou	None	5,000	......	......	......	......	......	......
Gardiner	2,200	2,000 6-in.	......	......	......	......	......	......
Houlton	176	205	......	......	......	......	......	......
Kennebunk	800	9,000 6-in	......	......	......	......	......	......
Kittery	None	600 6-in.	None	None	None	W. I.	1½-in. 1 in. ¾-in.	2,500 1,500 1,500-2,000
Livermore Falls	None	1000-6 in.	......	......	......	Galv. W. I.	2 in.	Ap. 1000
Rumford	None	3000-6 in.	None	None	None	None	......	......
Skowegan	4038	......	......	......	......	......	......	......
Van Buren	None	1100-6 in. 100-8 in.	......	......	None	None	......	......
Maryland:								
Washington—Suburban San. Dist.	851-1¼ in. 2992-2 in.	37,682-6 in. 16,389-8 in. 117-10 in. 13,695-12 in.	3705-16 in. 3777-20 in.	None	None	None	......	......
Massachusetts:								
Andover	None	2 mi.-6 in.	None	None	None	......	......	......
Athol	None	6056	None	None	None	None	......	......
Attleboro	6500	......	......	None	None	None	......	......

STREET MAINS LAID IN 1923

City	Cast Iron Mains: Under 6"	Cast Iron Mains: 6", 8", 10" & 12"	Cast Iron Mains: Larger than 12"	Steel Pipe: 12" or smaller	Steel Pipe: Larger than 12"	Other kinds	Size	Length, Ft.
Massachusetts (Continued)								
Belmont	......	9295-6 in. 5606-8 in. 1268-10 in.	......	......	......	......	......	......
Billerica	......	2500-6 in.	None	3000-2 in.	None	......	......	......
Brockton	......	7593	None	None	......	......	......	......
Brookline	None	3217	None	None	None	None	......	......
Cambridge	1070-4 in.	2453-6 in. 1843-8 in. 2-10 in. 160-12 in.	......	......	......	......	......	......
Chicopee	......	3 mi. 6 in. 1½ " 8 in.	......	......	......	......	......	......
Concord	2142	None	None	None	None	......	1½ in.	201
Danvers	143-4 in.	5552	None	None	None	......	......	......
Easthampton	None	200-6 in.	......	......	......	Galv.	¾-in.	900
Falmouth	12,800	None	None	None	None	Galv.	2 in.	1251
Fall River	None	252-12 in. 1180-10 in. 11403-8 in.	None	None	None	......	......	......
Fitchburg	3000-2 in.	3036	1020	None	......	None	......	......
Greenfield	2490	......	1019	None	......	......	......	......
Hadley	None	......	......	......	......	W. I.	¾-in.	300
Haverhill	816	1775	......	......	......	......	......	......
Holbrook	None	1200	......	None	None	None	......	......
Hyannis	1685	1053-6 in.	......	......	......	None	......	......
Lawrence	155-4 in. 329-2 in. 153-1½ in. 3112-1 in.	5396-8 in. 2333-6 in.	None	None	None	......	......	......
Maynard	400	400	None	None	None	......	......	......
Melrose	38	3055	......	......	......	None	......	......
Milford	None	2100-6 in.	None	None	None	None	......	......
New Bedford	570	20,758	None	None	None	......	......	......
Newburyport	None	800-6 in.	......	......	......	......	......	......
North Adams	278	1840	None	None	None	......	......	......
North Andover	None	2874	None	None	None	None	......	......
Orange	......	1000-6 in.	None	None	None	None	......	......
Peabody	None	14,872	None	None	None	None	......	......
Reading	......	360-6 in.	......	None	None	None	......	......
Revere	......	12,818	......	......	......	Galv.	2 in.	720
Shrewsbury	130-4 in.	......	......	......	......	......	......	......
Somerville	134	2257	None	None	None	None	......	......
Spencer	None	950-6 in.	......	None	None	None	......	......
Springfield	314	25,850	None	None	None	None	......	......
Swampscott	None	4448	698-14 in.	None	None	None	......	......
Waltham	None	5625	None	None	None	None	......	......
Wellesley	......	1531-10 in. 6154-6 in.	......	......	......	Galv. Galv.	2 in. 1 in.	960 6700
Weymouth	None	2938	None	None	None	None	......	......
Michigan								
Albion	250-4 in.	None	None	None	None	None	......	......
Alma	800-4 in.	900-6 in.	......	......	......	W. I.	2 in.	1200
Cheboygan	1800	None	None	None	None	None	......	......
Coldwater	850-4 in.	385-6 in.	......	......	......	......	......	......
Crystal Falls	400-4 in.	......	......	......	......	......	......	......
Dowagiac	None	2300-6 in.	None	None	None	W. I. W. I.	2 in. ¾-in.	484 4000
Escanaba	None	1600-6 in.	None	......	......	None	......	......
Hastings	740-4 in.	2756-6 in.	......	None	None	......	......	......
Houghton	......	500-10 in.	None	200	None	None	......	......
Jackson	1410	33,637-6 in 3,671-8 in 24-10 in 2,640-12 in	108-20 in.	None	None	None	......	......
Ludington	......	10,000-6 in 300-8 in.	......	......	......	......	......	......
Manistique	None	915-6 in.	None	......	......	......	1¼ in.	700
Marquette	400	None	None	None	None	None	......	......
Marshall	400-2 in.	1650-6 in.	None	......	......	......	......	......
Menominee	300-4 in.	......	......	......	......	......	......	......
Mt. Clemens	......	19,000-6 in.	......	......	......	......	......	......
Mt. Pleasant	½-mi.-4 in.	......	......	......	......	None	......	......
Muskegon H'ghts	2 mi.	......	......	None	None	......	......	......
Niles	1230-4 in.	3314-6 in.	None	None	None	Galv	2 in.	628
Petoskey	1000-4 in.	None	......	......	......	......	......	......
Rochester	747	912	None	None	None	None	......	......
St. Clair	None	250-8 in.	......	400	......	None	......	......
Traverse City	None	2000-6 in.	None	......	......	......	......	......
Minnesota								
Alexandria	None	3100-6 in.	......	......	......	......	......	......
Cloquet	1135-4 in.	2011-6 in.	......	......	......	None	......	......
Crookston	......	400-6 in.	......	None	......	None	......	......
Duluth	345	31,714	None	None	None	None	......	......
Hutchinson	1400	2000	None	None	None	None	......	......
Lake City	......	13 mi.-6 in.	None	None	None	None	......	......
Minneapolis	......	46,900-6 in. 17,913-8 in. 20,474-12 in.	12,837-16 in. 11,235-24 in.	......	......	......	......	......
Montevideo	640-4 in.	1408-6 in.	......	......	......	......	......	......
Moorhead	380-4 in.	1100-6 in. 1300-8 in.	None	None	None	None	......	......
Northfield	2021-4 in.	......	......	......	......	......	......	......
Staples	12,000-4 in 1,000-2 in	2000-6 in.	None	None	None	None	......	......
Stillwater	None	5681-6 in.	None	None	None	None	......	......
W. Minneapolis	......	1650-6 in.	......	......	......	......	......	......
Mississippi								
Amory	3500	2004-6 in.	......	......	......	......	......	......
Canton	800-4 in.	2200-6 in.	......	......	......	......	......	......

STREET MAINS LAID IN 1923

City	Cast Iron Mains: Under 6"	Cast Iron Mains: 6", 8", 10" & 12"	Cast Iron Mains: Larger than 12"	Steel Pipe: 12" or smaller	Steel Pipe: Larger than 12"	Other kinds	Size	Length, Ft.
Mississippi (Continued)								
Charleston	300	None	None	None	None	W. I.	4 in.	400
Clarksdale	1 mi.	None	None	None	None	None	......	......
Jackson	None	9000	200	None	None	None	......	......
Laurel	None	2000	None	2500	None	......	......	......
New Albany	600	None	None	None	None	......	1¼ in.	600
Vicksburg	None	2640-6 in.	None	None	None	......	......	......
Missouri								
Higginsville	1500	2000	......	......	......	......	......	......
Marceline	None	3200	None	None	None	None	......	......
Marshall	None	None	None	None	None	......	2 in.	450
Poplar Bluff	2000	None	None	None	None	......	......	......
Richmond	2007-4 in.	......	None	None	None	......	2 in.	600
Trenton	13,500	14,600-6 in.; 2,300-8 in.; 1,600-10 in.; 4,500-12 in.	None	None	None	......	......	......
Webster Groves..	1500-4 in.	None	None	None	None	Galv.	2 in.	2000
Montana								
Billings	2693	11,359	None	None	None	None	......	......
Bozeman	900-4 in.	800-6 in.	......	......	......	......	......	......
Glendive	2 mi.	2 mi.	None	......	......	......	......	......
Great Falls	None	None	375	5500	None	Galv.	2 in.	500
Missoula	None	1236-6 in.	None	None	None	None	......	......
Whitefish	None	None	None	None	None	Wood	4 in.	1329
Nebraska								
Auburn	1245-4 in.	4100-6 in.	None	100	......	Galv.	¾-in.	1000
Aurora	1379-4 in.	......	......	......	......	......	......	......
Chadron	712	......	......	......	......	......	......	......
Fremont	700-4 in.	......	......	None	None	None	......	......
Grand Island ...	222-4 in.	8796-6 in.	None	None	None	None	......	......
Holdrege	7200	700-6 in.	......	None	......	None	......	......
Kearney	2000	3500-6 in.	None	None	None	None	......	......
Sidney	None	None	None	None	None	Galv.	1½ in.	5000
University Place.	2000-4 in.	None	None	......	......	......	......	......
New Hampshire								
Claremont	None	1835	36	None	None	None	......	......
Dover	......	142-6 in.	......	......	......	W. I.; Galv.	2 in.; 2 in.	917; 228
Keene	......	5844-6 in.; 916-10 in.	......	......	......	......	......	......
Lebanon	None	250-6 in.	None	440-1½ in.; 160-1 in.	None	None	......	......
Newport	None	600	None	None	None	......	......	......
Somersworth	None	4000-6 in.; 4000-8 in.	......	......	......	......	......	......

(To be Continued)

PRESSURE IN WATER MAINS

City	Municipal (M) or Private (P)	Fire Service Direct from Pressure in Mains, or Fire Engines Used?	Ordinary Pressure in Mains: Maximum; Pounds	Ordinary Pressure in Mains: Minimum; Pounds	Increase in Pressure in Mains During Fire; Pounds
Alabama:					
Athens	M	Main pressure	100	60	60
Gadsden	M	Both	125	80	45
Mobile	M	....	81	81	Gravity
Opelika	P	Both	60	30	120
Talladega	..	Engines used	90	90	None
Troy	..	....	50	25	75
Arizona:					
Clifton	P	Fire engines	70	60	None
Douglas	M	Have fire engines—never used	65	40	....
Prescott	M	Main pressure	100	50	None
Arkansas:					
Benton	M	Main pressure	70	50	15
Harrison	M	Main pressure	95	88	To 140
Mena	M	Main pressure (65 lb. at hydrant)	100	90	None
Russellville ...	P	Fire engines	48	35	None
Searcy	M	Main pressure	60	50	60
Texarkana	P	Both	125	45	45 to 80
Van Buren....	M	Main pressure; have pumpers	105	100	....
West Helena...	P	Main pressure	45	38	None
California:					
Alhambra	M	Fire engines used	50	25	None
Anaheim	M	Both	40	35	To 100 if necessary
Carmel, Monterey, Pacific Grove & Pebble Beach....	P	Main pressure	115	40	....
Inglewood	M	Fire engines	45	35	None
Madera	M	Fire engines	50	50	None
Monterey Park.	M	Main pressure	90	25	....
National City..	P	Main pressure	70	40	....
Oxnard	M	Both	40	30	To 100
Palo Alto......	M	Both	45	30	To 100
Redlands	M	Main pressure	125	40	....
Riverside	M	Both	60	50	....
Salinas	P	Both	45	30	To 60
Santa Barbara.	M	Fire engines	115	75	Gravity
S. Pasadena...	M	Fire engines	60	20	....
Visalia	P	Both	40	..	To 45 to 50
Woodland	M	Fire engines	25	23	23
Colorado:					
Colorado Spgs.	M	Both*	155	50	Gravity
Sterling	M	Fire engines	46	40	None
Connecticut:					
Ansonia	P	Both	100	25	Gravity
Bridgeport	P	Fire engines	75	45	None
East Hartford.	M	Fire engines	70	45	Gravity
Putnam	M	Both	100	40	10 to 15
Southington ..	M	Main pressure	120	60	Gravity
Torrington ...	P	Both	85	..	Gravity
Westport	P	Fire engines	65	10	....
Willimantic ..	M	Main pressure	100	90	20 to 30
Florida:					
Fernandina ...	M	....	45	30	To 110
Plant City....	M	Fire engines	100	50	None
Georgia:					
Cedartown	M	Fire engine used	90	65	50
Cordele	M	Fire engine used	60	45	35
Decatur	M	Fire engine	60	45	....
Eastman	M	Main pressure	60	45	To 65
Eatonton	M	Main pressure	50	40	35 to 40
Elberton	M	Fire engines used	65	55	None
Griffin	M	Both	90	45	None
Hawkinsville..	..	Both	65	60	None

Pressure in Water Mains—Continued

City	Municipal (M) or Private (P)	Fire Service Direct from Pressure in Mains, or Fire Engines Used?	Ordinary Pressure in Mains: Maximum; Pounds	Ordinary Pressure in Mains: Minimum; Pounds	Increase in Pressure in Mains During Fire; Pounds
Georgia (Continued)					
La Grange....	M	Both	90	60	25
Thomaston	M	Main pressure	45	..	To 150
Thomasville ..	M	Both	35	..	....
Waynesboro ..	M	Main pressure	80	55	25
Idaho:					
Burley	M	Main pressure	65	60	None
Caldwell	M	Both	55	40	....
Coeur d'Alene..	P	Both	90	50	....
Lewiston	M	Both	90	75	....
Montpelier	M	Main pressure	75	50	Gravity
Preston	M	Fire engine	55	40	Gravity
Illinois:					
Abingdon	M	Main pressure	45	20	100
Bloomington ..	M	Both	70	70	None
Carmi	M	Main pressure	50	35	None
Cicero	M	Fire engines used	38	18	To 50
Elmhurst	M	Both	45	40	90 if necessar
Freeport	P	Both	95	40	To 100[c]
Galesburg	M	Fire engine used	45	45	None
Harvard	M	Fire engine	35	35	None
Lincoln	P	Main pressure	50	35	50
Mattoon	M	Fire engines used	60	30	None
Morrison	M	Main pressure	75	45	75
Mt. Carmel....	M[a]	Fire engine	40	25	90 to 100
Naperville	M	Fire engine	..	..	....
Nokomis	M	Main pressure[b]	52	40	Not much
Oak Park.....	M	Both	45	25	20
Peru	M	Fire engine	125	60	None
Princeton	M	Main pressure	55	40	To 100
Quincy	M	Fire engines used	120	20	None
Rockford	M	Fire engines	70	80	None
Rock Island...	M	Fire engines	60	60	....
Silvis	M	Both	85	78	None
Waukegan	M	Both	35	20	20
White Hall....	M	Main pressure	50	30	None
Indiana:					
Brazil	M	Main pressure	70	70	30
Columbus	M	Main pressure	60	60	40
Connersville ..	M	Both	70	65	15
Crawfordsville.	P	Main pressure	110	50	40
Crown Point..	M	Both	35	25	10 to 25 if requn l
Decatur	M	Both	35	30	70 to 100
Elwood	P	Main pressure	90	40	50
Fort Wayne...	M	Fire engines used	50	50	None
Gary	P	Main pressure[b]	60	45	To 100 or 105
Huntington ...	M	Fire engine	70	60	None
Lafayette	M	Main pressure	98	50	None
Laporte	M	Main pressure	45	40	50
Lebanon	M	Main pressure	55	50	....
Linton	M	Main pressure	60	..	90
Nappanee	P	Fire engine	50	48	None
New Albany...	P	Both[g]	80	70	None
Richmond	P	Both	70	70	80 to 50
Rushville	M	Both	100	45	55
Seymour	P	....	60	50	To 90
Shelbyville	P	Main pressure	65	55	To 110
South Bend....	M	Both	80	50	85 to 100
West Lafayette	P	Both	65	65	75 to 80
Whiting	M	Main pressure[b]	35	24	To 75
Iowa:					
Ames	..	Both	60	30	100 if required
Belle Plaine...	M	Fire engine	80	60	None
Burlington	P	Both[g]	110	100	25 to 35
Cedar Rapids..	M	Both[e]	80	30	None
Charles City...	M	Both	50	40	125
Cherokee	M	Both	85	35	....
Council Bluffs.	M	Both[g]	125	60	40
Des Moines....	M	Both[g]	95	20	20 for extreme hazards

Pressure in Water Mains—Continued

City	Municipal (M) or Private (P)	Fire Service Direct from Pressure in Mains, or Fire Engines Used?	Ordinary Pressure in Mains: Maximum; Pounds	Ordinary Pressure in Mains: Minimum; Pounds	Increase in Pressure in Mains During Fire; Pounds
Massachusetts:					
Andover	M	Both	125	15	....
Athol	M	Both	135	80	None
Attleboro	M	Main pressure	135	80	Maintains 100
Belmont	M	....	160	35	Gravity
Bellerica	M	Main pressure	125	54	10
Brookline	M	Mostly main pressure	100	30	None
Cambridge ...	M	Fire engines	60	55	....
Chicopee	M	Fire engines used	129	95	....
Concord	M	Fire engine	100	20	....
Danvers	M	Both	95	30	None
Easthampton .	M	Main pressure	100	90	None
Fall River....	M	Main pressure	80	30	....
Fitchburg	M	Main pressure	175	30	Gravity
Hadley	M	Main pressure	85	35	Gravity
Haverhill	M	Both	120	30	None
Holbrook	M	Main pressure	70	55	10
Lawrence	M	Both	130	30	None
Maynard	M	Main pressure	115	50	None
Medway	M	Main pressure	100	..	....
Melrose	M	Fire engine	95	35	None
Milford	P	....	75	75	35
Montague	P	Both	35	..	60
New Bedford....	M	Both	90	14	None
Newburyport .	M	Fire engines used	65	40	None
North Adams..	M	Both	175	10	Gravity
North Andover	M	Both	145	28	5
Orange	M	Main pressure	130	26	....
Oxford	P	....	120	70	None
Peabody	M	Fire engines used	80	50	....
Reading	M	Main pressure	90	55	....
Shrewsbury ..	M	Both	170	55	None
Somerville	M	Fire engines	100	35	Gravity
Springfield ...	M	....	140	70	Gravity
Swampscott ..	M	Fire engines	80	70	None
Waltham	M	Fire engines used	100	40	None
Wellesley	M	Fire engines used	125	40	None
Weymouth ...	M	Both[e]	75	20	40
Michigan:					
Albion	M	Both	80	45	10
Cheboygan ...	M	Main pressure	30	20	80
Crystal Falls..	M	Fire engine used	125	45	....
Dowagiac	M	Main pressure	100	50	50
Escanaba	M	Fire engines used	45	35	None
Hancock	M	Both	85	..	100 to 110
Highland Park	M	Fire engines	42	42	None
Houghton	M	Main pressure	80	45	140[d]
Ironton Mt....	M	Main pressure	90	30	None
Jackson	M	Fire engines used	60	30	None
Ludington	M	Main pressure	55	40	85 to 100
Manistique	M	Both	45	35	To 100
Marquette	M	Main pressure	100	90	15 to 20
Marshall	M	Both	65	40	10
Menominee ..	M	Fire engines	60	60	None
Mt. Clemens ..	M	Both	65	65	20 to 30
Mt. Pleasant...	M	Main pressure	50	40	40 to 60
Muskegon Hts..	M	Fire engines	60	56	....
Niles	M	Main pressure	80	70	None
Otsego	M	Main pressure	65	60	30
Petoskey	M	....	110	35	10
Rochester	M	Main pressure	60	50	Gravity
St. Clair.......	M	Main pressure	65	60	70
South Haven...	M	Both	45	37	30
Traverse City..	M	Both[e]	60	60	To 90
Minnesota:					
Alexandria	M	Fire engine	55	40	To 100
Bemidji	M	Main pressure	60	55	....
Cloquet	M	Both	110	70	None
Crookston	P	Fire engine	45	45	....

Denison	M	....	100	60	....
Dubuque	M	Fire engines	150	90	None
Ft. Dodge	M	....	105[e]	..	None
Ft. Madison	P	Main pressure	75	70	25 if necessary
Indianola	M	Both	45	..	None
Iowa Falls	M	....	60	50	....
Knoxville	M	Main pressure	60	55	To 70
Marshalltown	M	Both[g]	80	40	30—serious fires
Mason City	M	....	75	60	None
Mt. Pleasant	M	Main pressure	35	25	To 115
Muscatine	M	Both	75	30	100
Newton	M	Both	56	25	....
Sioux City	..	Both	107	35	None
Vinton	M	Both	75	65	35
Washington	M	Both	47	45	40
Winterset	M	Fire engine used	55	40	None
Kansas:					
Augusta	M	....	60	50	20
Council Grove	M	Main pressure	65	55	To 100 if necessary
Dodge City	M	Main pressure	115	..	....
Fredonia	P	Main pressure	85	65	None
Galena	M	Main pressure	75	65	None
Garden City	M	Main pressure	40	30	To 100
Hiawatha	M	Main pressure	60	50	40 to 50
Humboldt	M	Main pressure	50	40	5
Independence	M	....	70	65	100 to 110
Junction City	M	Both[g]	80	74	None
Lyons	M	Main pressure	65	55	To 125
McPherson	M	Both	45	25	To 85
Osawatomie	..	Main pressure	70	50	....
Ottawa	M	Main pressure	60	50	25 to 40
Pittsburg	M	Main pressure	50	50	110
Pratt	M	Fire engine	40	30	None
Salina	P	....	110	70	40
Kentucky:					
Covington	M	Both	130	95	....
Fort Thomas, Bellevue & Dayton	P	Fire engines	70	..	None
Fulton	M	Both	100	75	....
Glasgow	P	Main pressure	45	35	10 to 20
Hopkinsville	P	Main pressure	100	70	25
Jenkins	P	Main pressure	68	..	To 100-125
Lexington	P	Main pressure	65	50	35 to 50
Louisville	M	Both	75	40	10 to 15
Mayfield	M	Both	55	55	To 100 or more
Morganfield	M	Main pressure	70	45	To 100-125
Paris	P	Both	60	40	To 90
Pineville	P	Both[g]	60	60	95
Richmond	P	Main pressure	75	50	50
Louisiana:					
Alexandria	M	....	40	30	95
Crowley	M	Fire engine	45	25	20
Donaldsonville	M	Main pressure	40	35	To 100
Leesville	P	....	60	50	None
Rayne	M	Main pressure	35	35	75
Maine:					
Bangor	M	....	120	35	None
Calais	P	Main pressure	120	110	Gravity
Caribou	P	Both	105	76	15
Gardiner	M	Both	97	27	5 to 15
Houlton	..	Main pressure	100	60	None
Kennebunk	M	Main pressure	80	60	....
Kittery	M	Both	85	65	Gravity
Livermore Falls	M	Main pressure	120	50	60
Rockland, Rockport, Camder, Thomaston	P	Both	110	75	None
Rumford	M	Both	120	30	Gravity
Skowhegan	P	Both	75	65	None
Van Buren	M	Main pressure	80	40	40
Maryland:					
Washington Suburban District	M	Main pressure	140	50	None
Fairmont	M	Fire engine	60	55	None
Hutchinson	P	Main pressure	100	60	None
Intern'l Falls	M	Main pressure	69	49	110
Lake City	M	....	85	60	25
Minneapolis	M	Both	75	30	None
Montevideo	M	Both	80	60	30
Moorhead	..	Main pressure	50	45	To 100
Northfield	M	Main pressure	90	65	....
St. Peter	M	Main pressure	80	80	....
Staples	M	Main pressure	53	40	To 125
Two Harbors	M	Both	65	60	To 110
W. Minneapolis	M	Fire engine used	60	60	....
Willmar	M	Fire engine used	38	34	....
Mississippi:					
Amory	M	Main pressure	65	50	25
Canton	M	Main pressure	80	35	25
Charleston	M	Main pressure	..	40	60
Clarksdale	M	Both	50	30	Some
Greenville	M	Main pressure	40	40	70 to 125
Jackson	M	Both	75	..	25
Laurel	M	Fire engine used	110	45	40 to 70
New Albany	M	Main pressure	55	40	50
Vicksburg	M	Both	135	22	None
Missouri:					
Hannibal	M	Both	110	20	....
Higginsville	M	Main pressure	60	40	50
Liberty	M	Fire engine used	97	50	None
Marceline	M	Main pressure	75	60	15
Marshall	M	Fire engine mostly	70	40	....
Poplar Bluff	M	Both	65	50	To 120
Richmond	..	Main pressure	70	60	20
St. Louis	M	Fire engines	75	20	None
Webster Groves	M[b]	Both	60	40	None
Montana:					
Anaconda	P	Both[g]	90	70	Gravity
Billings	M	Fire engines	70	60	10
Bozeman	M	Main pressure	100	90	Gravity
Glendive	M	Fire engine	86	60	26
Havre	M	Fire engine	75	65	10
Kalispell	M	Fire engines	70	50	None
Miles City	M	Main pressure	58	45	To 120
Missoula	P	Fire engines	90	50	Gravity
Whitefish	M	Main pressure	56	30	15
Nebraska:					
Aurora	M	Both	47.5	25	45
Chadron	M	Main pressure	60	40	....
Grand Island	M	Main pressure	55	40	100
Holdrege	M	Fire engines	90	..	To 160
Kearney	M	Fire engines	40	25	25
Schuyler	M	Fire engines	44	30	To 125-175
Sidney	M	Main pressure	66	45	None
University Pl.	M	Main pressure	60	50	To 100
New Hampshire:					
Claremont	M	Main pressure	130	50	Gravity
Dover	M	Main pressure	114	54	....
Haverhill	..	Main pressure	135	65	Gravity
Keene	M	Fire engines	90	40	Gravity
Newport	M	....	125	..	Gravity
Somersworth	M	Main pressure[b]	129	35	....
New Jersey:					
Bridgeton	M	Fire engines	60	30	None
Cape May	M	Fire engines	55	..	....
Edgewater	P	Fire engines	95	65	Gravity
Egg Harbor	M	Fire engines	50	38	....
Hightstown	M	Main pressure	66	55	10
Irvington	P	Both	130	60	75
Merchantville	P	Both	60	25	Very little
Newton	M	Main pressure	85	55	Gravity
Phillipsburg	P	Fire engines	112	35	None
New Mexico:					
Albuquerque	M	....	100	..	None
Deming	M	Fire engines	33	20	35
New York:					
Amityville	P	Both	54	45	75
Auburn	M	Main pressure	135	28	35
Avon	M	Main pressure	110	40	Gravity

Pressure in Water Mains—Continued

City	Municipal (M) or Private (P))	Fire Service Direct from Pressure in Mains, or Fire Engines Used?	Ordinary Pressure in Mains		Increase in Pressure in Mains During Fire; Pounds
			Maximum; Pounds	Minimum; Pounds	
New York (Continued)					
Brockport	M	Main pressure	65	55	10
Canastota	M	Both	100	75	25
Canton	M	Fire engine used	50	40	None
Cortland	M	Main pressure	74	70	None
Dansville	M	....	120	40	Gravity
East Syracuse	M	Main pressure	80	60	Gravity
Elmira	M	Both	70	..	None
Fairport	M	Both	85	75	....
Frankfort	M	Main pressure	105	60	Gravity
Geneva	..	Both	135	75	None
Glens Falls	M	Both	100	80	....
Herkimer	M	Both	75	65	None
Hoosic Falls	M	....	90	..	....
Hudson Falls	P	Fire engines	70	50	None
Johnson City	M	Both	105	80	None
Le Roy	M	Both	60	..	Gravity
Little Falls	M	Main pressure	140	35	80[h]
Lowville	M	Main pressure	160	80	Gravity
Lyons	M	Fire engines	85	70	None
Malone	M	Main pressure	95	50	....
Mechanicsville	M	Main pressure	76	70	....
Mohawk	M	Main pressure	75	70	10
Mount Vernon	M	Fire engines	110	30	None
Newark	M	Both[g]	75	..	Gravity
Norwich	P	Fire engines used	70	60[1]	Gravity
Ogdensburg	M	Both	50	40	20 to 25
Oswego	M	Both[g]	60	20	40
Peekskill	M	Main pressure	175	48	Whatever necessary
Port Jervis	P	Both[g]	60	40	None
Scarsdale	M	Both	125	26	None
Scotia	M	Main pressure	95	60	None
Seneca Falls	P	Both	50	..	....
Sidney	M	Both	80	20	75
Syracuse	M	Both	105	20	None
Tarrytown	M	Both[e]	220	60	....
Waterford	M	Main pressure	100	70	30
Watertown	M	Both	94	40	None
Wellsville	M	Main pressure	90	50	None
North Carolina:					
Albemarle	M	Both	80	60	20
Gastonia	M	Fire engines used	65	60	None
Greensboro	M	Main pressure	125	65	None
Henderson	P	Fire engines used	60	40	None
Kings Mount'n	M	Main pressure	70	50	None
Kinston	M	Fire engines used	60	50	To 70
Mooresville	M	Fire engines	60	50	None
Newton	M	Both	85	60	40
Spencer	M	Main pressure	70	..	....
Statesville	M	Both	60	50	To 150
Wilmington	M	Both	76	55	40
North Dakota:					
Fargo	M	Both	65	50	To 90[k]
Mandan	M	Fire engines	80	..	None
Valley City	M	Fire engines	65	50	None
Wahpeton	M	Fire engines	35	30	20
Williston	M	Both	65	..	None
Ohio:					
Athens	M	Both	120	40	None
Barberton	M	Fire engines	75	60	None
Bedford	M	Main pressure	90	40	None
Cincinnati	M	Both	175	35	None
Conneaut	M	Both[g]	135	38	35
Dayton	M	Fire engines	120	50	None
Defiance	M	Fire engines	65	45	None[k]

Pressure in Water Mains—Continued

City	Municipal (M) or Private (P))	Fire Service Direct from Pressure in Mains, or Fire Engines Used?	Ordinary Pressure in Mains		Increase in Pressure in Mains During Fire; Pounds
			Maximum; Pounds	Minimum; Pounds	
Rhode Island:					
E. Providence	P	Main pressure	135	110	None
Narragansett Pier	P	Both	90	30	None
Pascoag	P	Main pressure	130	50	None
Pawtucket	M	Main pressure	110	..	None
Providence	M	Both	70	..	55[m]
Woonsocket	M	....	140	20	None
South Carolina:					
Abbeville	M	Both	80	40	To 100
Batesburg	M	Main pressure	45	..	85
Bennettsville	M	Both	75	..	To 125
Charleston	M	Fire engine used	40	30	None
Cheraw	M	Fire engine used	70	50	None
Columbia	M	Both[g]	125	43	None
Darlington	P	Fire engine	65	60	....
Easley	M	Main pressure	65	55	None
Florence	M	Both	60	45	....
Greenville	M	Both	60	50	Gravity
Spartanburg	M	Main pressure	100	40	20
South Dakota:					
Brookings	M	....	65	..	....
Tennessee:					
Clarksville	M	Both	110	40	None
Dyersburg	M	Fire engines	80	60	None
Erwin	P	Main pressure	83	60	None
Harriman	M	Main pressure	110	..	30
Humboldt	M	Fire engine used	45	40	20 to 30
Murfreesboro	M	Fire engine	75	60	To 100
Newport	M	Fire engine used	80	40	Gravity
Paris	M	Main pressure	55	45	To 125
Shelbyville	P	....	80	45	To 100
Tullahoma	M	Both	50	40	To 80
Texas:					
Cameron	P	Fire engine	50	40	15
Cleburne	M	Main pressure	50	..	To 75
Corpus Christi	M	Both	75	45	....
El Paso	M	Both	80	20	None
Ennis	M	Fire engine used	50	40	50
Gainesville	M	Main pressure	60	..	To 130
Galveston	M	Both	60	..	30
Graham	M	Main pressure	75	60	15 to 20
Jacksonville	M	Fire engine	80	..	....
Lockhart	P	Both	50	40	125
McKinney	M	Fire engine used	40	..	8
Marlin	M	Fire engine used	60	..	None
Mart	M	Both	56	20	Small am't
Memphis	P	Main pressure	110	60	None
Mineral Wells	M	Both	85	..	35 to 55
Mt. Pleasant	M	Main pressure	70	40	....
Port Arthur	..	Both	60	..	30
Quanah	M	Fire engine used	65	60	60
Smithville	P	Fire engine	60	..	To 100-120
Sweetwater	M	Main pressure	35	30	30 to 40
Yoakum	P	Main pressure	54	..	100
Utah:					
Logan	M	Both	120	85	100
Murray	M	Fire engines used	60	10	Gravity
Salt Lake City	M	Fire engines used	110	105	Gravity
Vermont:					
Barton	M	Main pressure	135	100	Gravity
Bennington	M	Main pressure	137	34	Gravity
Brattleboro	P	Main pressure	150	..	Gravity
Windsor	M	Both	..	..	....

East Liverpool.	M	Main pressure	150	75	None
Eaton	M	Main pressure	60	50	To 90
Elyria	M	Main pressure	50	40	15 to 20
Findlay	M	Both	65	..	45
Fremont	M	Both	55	45	To 90
Galion	M	Main pressure	50	35	To 70 to 80
Gallipolis	M	Main pressure	120	..	Very little
Kent	M	Both	103	80	None
Lakewood	M	Fire engines	115	20	None
Lancaster	M	Both	120	90	Seldom
Lorain	M	Both	70	40	80
Marietta	M	Both	95	85	Very little
Medina	M	Fire engine	65	30	None
Miamisburg ...	M	Main pressure	80	70	None
Mingo Junction	P	Both	150	135	15
Montpelier	M	Main pressure	90	40	50
Niles	M	Both	100	20	20
Struthers	P	Both	110	75	None
Tiffin	P	Both	60	40	40
Toledo	M	Fire engines used	75	45	None
Up. Sandusky..	P	Fire engines	40	..	40
Urbana	M	Main pressure	40	40	To 80
Willoughby ...	M	Fire engines	60	55	None
Wilmington	P	Main pressure	53	45	40
Oklahoma:					
Ada	M	Fire engines	67	30	To 72
Clinton	M	Main pressure	50	40	10
Guthrie	M	Both	80	70	All needed
Henryetta	M	Both	80	..	20
McAlister	M	Both	65	50	None
Mangum	M	Main pressure	55	35	None
Newkirk	M	Main pressure	60	50	None
Okmulgee	M	....	100	40	20 to 40
Walters	M	Main pressure	50	40	80
Oregon:					
Corvallis	M	Fire engines	65	50	None
Pendleton	M	....	110	100	Gravity
Pennsylvania:					
Allentown	M	Fire engines mostly	130	20	None
Ambler	P	Both	70	30	70
Barnesboro ...	M	Fire engines	120	70	....
Bellwood	M	Fire engines	60	..	....
Carbondale ...	P	Both	120	80	None
Catasauqua ...	M	Fire engines	90	50	None
Danville	M	Both	85	..	....
Duquesne	M	Both	170	30	None
Elizabeth	P	Both	150	25	None
Emporium	P	Both	70	50	20
Franklin	M	Main pressure	60	45	90
Freeland	P	Both	120	20	20
Freeport	P	Fire engine	100	80	To 150
Honesdale	P	....	60	..	30 to 70[l]
Huntington ...	M	Both	95	70	15
Indiana	P	Both	100	85	....
Jersey Shore...	P	Fire engine	125	45	35
Johnsonburg ..	M	Both	130	..	....
Kittanning	P	Both	80	70	None
Lancaster	M	Fire engines used	100	20	None
McDonald	P	Main pressure	110	70	None
Meyersdale	P	....	90	..	None
Meadville	M	Both	120	65	None
Millersburg ...	P	Both	60	..	....
Monaca	M	....	125	..	15
Norristown ...	P	Fire engines used	90	25	None
North East....	M	Fire engine	100	40	None
Osceola	..	Both	90	..	....
Phoenixville ..	M	Fire engines used	50	25	....
Sayre	P	Both	87	..	None
Shamokin	P	Fire engines	140	20	Gravity
Sharpsville ...	M	Both	90	15	30
Susquehanna ..	P	Both	130	35	Gravity
Titusville	M	Main pressure	125	75	15 to 50
Uniontown	P	Both	115	90	Gravity
Warren	P	Both[g]	85	80	To 125
Wellsboro	P	Main pressure	85	30	None
Windber	P	Main pressure	110	30	Gravity
Virginia:					
Clifton Forge..	M	Both	125	30	Gravity
Lexington	M	Main pressure	65	25	....
Martinsville ..	..	....	70	30	....
Norfolk	M	Both	40	30	10 to 20
Richmond	M	Fire engines	110	25	None
Washington:					
Aberdeen	M	Both	85	..	Gravity
Anacortes	M	Main pressure[b]	90	30	None
Auburn	M	Main pressure	85	60	None
Pullman	M	Main pressure	90	30	17
Raymond	M	Main pressure	60	..	15
Spokane	M	Both	95	30	None
Tacoma	M	Both	170	25	....
Walla Walla...	M	Main pressure	110	..	Gravity
West Virginia:					
Beckley	P	Main pressure	80	50	5
Follansbee	P	Main pressure	150	..	....
Morgantown ..	P	Both	135	50	None
Princeton	P	Both	130	65	None
Salem	M	Main pressure	100	15	60
Welch	P	Fire engine	100	85	To 125
Weston	P	Main pressure	125	100	None
Wisconsin:					
Appleton	M	Main pressure	60	50	30 occasionally
Baraboo	M	....	75	70	100
Beaver Dam...	M	Fire engine	55	..	....
Chippewa Falls	M	Both[g]	80	65	30 to 40
Clintonville ...	M	Fire engines used	65	55	None
Delavan	M	Main pressure	27	32	50
Edgerton	M	Main pressure	75	..	To 120
Hartford	M	Fire engine used	65	40	None
Janesville	M	Both	75	..	25
Jefferson	M	Main pressure	65	55	To 100
Kaukauna	M	Fire engine	60	32	110
Kenosha	M	Fire engines used	60	30	5
Lacrosse	M	Main pressure	100	85	None
Ladysmith.....	M	Main pressure	125	60	....
Lancaster	M	Main pressure	40	..	50 to 60
Madison	M	Fire engine	80	30	None
Manitowoc	M	Both	60	45	40
Marinette	P	Main pressure	50	40	100 & up
Menasha	M	Both	65	50	None
Menomonee ...	M	Main pressure	120	80	20
Merrill	P	Main pressure	45	..	45
Milwaukee	M	Fire engines & fireboats	90	20	....
Neenah	M	Main pressure	50	40	90
Reedsburg	M	Main pressure	65	45	None
Ripon	P	Fire engine	50	40	None
Shawano	M	Main pressure	40	35	To 100
Shorewood	M	....	80	16	....
So. Milwaukee.	M	Fire engine	60	40	None
Sparta	M	Fire engine	55	45	To 125
Stevens Point.	M	....	65	50	To 100
Sturgeon Bay..	M	Main pressure	60	40	100 to 110
Superior	P	Both	70	60	50
Watertown ...	M	Both	125	75	....
Wausau	M	Main pressure	60	..	30
Wauwatosa ...	M	Both	95	40	None
West Bend....	M	....	70	40	10 to 20
Wisconsin Rapids	M	Main pressure	70	65	None
Wyoming:					
Cheyenne	M	Both[g]	130	110	Gravity
Laramie	M	Fire engines used	40	10	Gravity

[a]—Municipally owned, but operated under private lease. [b]—Fire engine (pumper) will be in possession of city soon. [c]—At pumping plant. [d]—By drawing on high service reservoir. [e]—Fire engines used for big fires only. [f]—Distribution municipal, supply private. [g]—Fire engines used only occasionally. [h]—Gravity system; pressure increased by by-passing pressure-reducing valves. [i]—Falls to 30 lbs. while filters are being cleaned, at 5 to 6 A. M. [k]—Increase in extraordinary emergencies. [l]—Gravity system; pressure increased by drawing from higher reservoir. [m]—Gravity system; pressure increased by using full reservoir head.

PUMPING PLANTS

City	Kind in Regular Service	Kind in Reserve	Change Made During Past Five Years: From	Change Made During Past Five Years: To (or plant added)
Alabama:				
Athens	Electric	Steam	None	......
Gadsden	Electric	......	None	......
Mobile	Steam	Steam	None	......
Opelika	Electric	Steam	......	......
Talladega	Electric	Steam	Steam	Electric
Troy	Electric	......	......	Electric
Arizona:				
Clifton	Oil	Oil	None	......
Douglas	Oil	Oil	None	......
Glendale	Electric	Gasoline	None	......
Prescott	Gravity supply	Electric	Electric	Gravity
Arkansas:				
Benton	Electric	Steam	None	......
Harrison	Electric	Oil	Oil	Electric
Mena	Elec. (3 mos. in the year only)	None	......	Electric
Russellville	Electric	None	None	......
Searcy	1 steam, 1 elec.	Electric	......	Electric
Texarkana	Steam & oil	Steam	None	......
Van Buren	Electric	Electric	Steam	Electric
West Helena	Steam	Electric	None	......
California:				
Alhambra	Electric	Electric (another source)	None	......
Anaheim	Electric	......	......	......
Benicia	Electric	Electric	Steam	Electric
Carmel, Pebble Beach, Monterey & Pacific Grove	Electric	......	......	......
Dinuba	Electric	Gasoline	......	......
Fullerton	Electric	None	Compressed air	Electricity
Inglewood	Electric	Steam	Steam	Electric
Madera	4 electric	1 gas	None	......
Maryville	Electric	Steam	None	......
Modesto	Electric	Diesel & elec.	None	......
Monterey Park	Electric	Electric	None	......
Oxnard	Steam & elec.	Steam & elec.	None	......
Palo Alto	Electric	None	None	......
Redlands	Steam & elec.	Steam	None	......
Riverside	Electric	......	None	......
Salinas	Electric	Steam	None	......
South Pasadena	Electric	None	None	......
Upland	Electric	......	None	......
Visalia	Electric	......	None	......
Woodland	2 electric	1 steam, 1 gas	......	2 electric
Colorado:				
Sterling	Electric	Electric	None	......
Connecticut:				
Bridgeport	Gravity supply	2 steam	None	......
Putnam	Water power, steam & elec	Steam & elec.	......	Electric
Westport	Water power	Steam	None	......
Willimantic	Water power	Steam	None	......
Florida:				
Fernandina	Electric	Steam	Steam	Electric
Plant City	Oil	Electric	......	Electric
Georgia:				
Bainbridge	Electric	......	......	Electric
Cedartown	Electric	Steam	......	......
Cordele	Steam	Steam	None	......
Decatur	Electric	Steam	......	......
Eastman	Electric	None	......	......
Eatonton	Steam	Steam	None	......
Elberton	Electric	......	Steam	Electric
Griffin	Electric	Steam	None	......
Hawkinsville	Steam & elec.	Steam	......	......

City	Kind in Regular Service	Kind in Reserve	Change Made During Past Five Years: From	Change Made During Past Five Years: To (or plant added)
Indiana—(Continued):				
South Bend	Steam & elec	None	Hydraulic	Electric
West Lafayette	Steam	Steam	None	......
Whiting	Electric	Steam	Steam	Electric
Iowa:				
Ames	Electric	Steam	None	......
Belle Plaine	Electric	Turbo gas & electric	......	Turbos added
Boone	Steam & elec.	Steam	......	Electric added
Burlington	Steam	Steam	None	......
Cedar Rapids	Steam	Steam	Elec. well pump	Steam driven air compressor
Charles City	Electric	Electric	None	......
Cherokee	Electric	Steam	None	......
Council Bluffs	Elec. & steam	Steam	......	3 elec. added
Des Moines	Steam	Steam	None	......
Denison	Electric	Steam	None	......
Dubuque	Steam & elec.	Steam & elec.	Now changing	to all electric
Ft. Dodge	Electric	Steam	Steam	Electric
Ft. Madison	Steam	Steam	None	......
Indianola	Electric	Steam	......	......
Iowa Falls	Steam	Electric	......	Electric added
Knoxville	2 electric	2 elec. & steam	None	......
Maquoketa	Diesel electric	Steam	Steam	Electric
Marshalltown	Steam	Steam	None	......
Mason City	Steam	Steam	Electric	Steam
Mt. Pleasant	Electric	Steam	None	......
Muscatine	Steam	......	......	Electric just added
Newton	Electric & oil	Steam	Steam	Electric
Sioux City	Steam & oil-electric	......	None	......
Vinton	Electric	Steam	None	......
Washington	Steam	Steam	None	......
Winterset	Electric	Electric	None	......
Kansas:				
Augusta	Electric	......	......	......
Council Grove	Electric	Gaso. & steam	Steam	Electric
Dodge City	Electric	Steam	Steam	Electric
Fredonia	Steam & elec.	Low duty, elec; high, steam	None	......
Galena	Electric	None	Steam	Electric
Garden City	Electric	Electric	None	......
Hiawatha	Electric	......	None	......
Humboldt	Steam	......	None	......
Hutchinson	Electric	Steam	Steam	Electric
Independence	Steam	Steam	None	......
Junction City	Steam	Steam	None	......
Lyons	Elec. & steam	Steam	......	Electric added
McPherson	Electric	......	None	......
Osawatomee	Steam & elec.	Steam	None	......
Ottawa	Steam	Steam	None	......
Pittsburg	Steam	Steam turbine	None	......
Salina	Steam & elec.	Steam	Steam	Electric
Kentucky:				
Bellevue, Dayton & Ft. Thomas	Electric	None	None	......
Covington	Steam	Steam	......	Electric added
Fulton	Steam	Steam	None	......
Glasgow	Oil	Electric	......	Oil
Hopkinsville	Steam	Steam	None	......
Jenkins	Electric	......	None	......
Lexington	Steam & elec. (own generation)	Gasoline	......	Gasoline & electric added
Louisville	8 steam	1 steam	None	......
Mayfield	Steam & elec.	Steam	......	......
Morganfield	Elec. & steam	......	Steam	Electric

Lagrange	Electric	Electric	None	......
Thornton	Steam & elec.	Steam & elec.	......	......
Thomasville	Electric	Steam	......	......
Waynesboro	Steam & elec.	......	None	......
Idaho:				
Boise	Electric	Steam	None	......
Burley	Electric	......	......	......
Caldwell	Electric	Gasoline	......	......
Coer d'Alene	Electric	Steam	None	......
Lewiston	Electric	Electric	......	......
Weiser	Electric	Electric	None	......
Illinois:				
Abingdon	Steam	None	None	......
Bloomington	Steam	Steam	......	Electric aux.
Carmi	Electric	Steam	Steam	Electric
Christopher	Electric	Electric	None	......
Cicero	Steam (electric booster)	Electric	None	......
Elmhurst	Diesel oil	Diesel oil	Electric	Oil
Freeport	Steam	Steam	None	......
Galesburg	Electric	Gaso. & steam	Steam	Electric
Geneva	Electric	Gasoline	Steam	Electric
Harvard	Electric	Gasoline	......	Gasoline added
Hinsdale	Steam	Steam	None	......
Hoopeston	Steam	None	None	......
Lake Forest	Electric	Gasoline	Steam	Electric
Lincoln	Steam & elec.	Steam & elec.	None	......
Mattoon	Elec. & steam	Elec. at steam plant, gasoline at elec. plant	Steam	Electric
Metropolis	Steam	None	None	......
Morrison	Steam	Steam	......	Steam added
Mt. Carmel	Electric	Steam	Steam	Electric
Naperville	Elec. & steam	......	......	......
Nokomis	Oil	Electric	Electric	Oil
Oak Park	Electric	Electric	......	......
Peru	Steam	Steam	None	Unaflow just added
Princeton	Steam & elec.	Steam	......	......
Quincy	Electric	Steam	None	......
Rockford	Steam	Electric	......	Steam added, wells electrified
Rock Island	Low service, steam; high, electric	Low, steam; high, electric	......	......
Silvis	Electric	Electric	None	......
Springfield	Steam	Steam & elec.	......	......
Waukegan	Steam	Electric	......	Electric
White Hall	Electric	Gasoline	None	......
Indiana:				
Brazil	Steam	......	......	......
Columbia	Steam & elec.	......	None	......
Connersville	Steam	None	None	......
Crawfordsville	Steam	......	......	......
Crown Point	Electric	......	Steam	Electric
Decatur	Electric	Steam	Steam	Electric
Elwood	Steam	......	None	......
Evansville	Steam	Steam turbine	None	......
Fort Wayne	Electric	......	Steam	Electric
Gary	Electric	Electric	None	......
Huntington	Steam & elec.	......	None	......
Jasper	Electric	None	None	......
Lafayette	Electric	Steam	Steam	Electric
La Porte	Steam, elec., oil	Steam, elec., oil	......	Oil added
Lebanon	Steam & elec.	Electric	......	......
Linton	Electric	Steam	None	......
Menasha	Steam	Electric	......	Electric added
Nappanee	Electric	Electric	......	Electric added
New Albany	Elec. & steam	Steam	Steam	Electric
Newcastle	Steam	Steam	None	......
Richmond	Steam	......	......	......
Rushville	Steam & elec.	Steam	Steam	Electric
Seymour	Hydraulic	Steam	None	......
Shelbyville	Steam	Steam	None	......

Paris	Steam	Steam	None	......
Pineville	Steam	Steam	None	......
Richmond	Steam	None	None	......
Louisiana:				
Alexandria	Steam & elec.	......	......	......
Covington	Electric	Electric	Steam	......
Crowley	Electric	Diesel-electric	Plunger	Electric deep well
Donaldsonville	Electric	Electric	None	......
Leesville	Steam	Steam	None	......
Mansfield	Gas	......	None	Centrifugal Diesel engine for elec. cur.
Rayne	Electric	......	......	
Maine:				
Bangor	Water power	Steam	None	......
Camden & Rockland	None	Elec. & Diesel	Steam	Diesel
Caribou	Electric	Electric, different source	......	2 electric
Gardiner	Water power	Electric	None	......
Houlton	Electric	Steam	None	......
Kennebunk	Electric	Steam	Steam	Electric
Livermore Falls	Electric	Electric	......	Electric added
Skowhegan	Electric	Electric	None	......
Van Buren	Gasoline	None	None	......
Maryland:				
Washington Suburban San. District	3 electricity	3 gasoline	1 oil	Electricity
Massachusetts:				
Andover	1 steam, 1 oil, 1 electric	Two of the three	None	......
Attleboro	Steam	Steam	None	......
Billerica	Steam	Steam	......	......
Brockton	Steam	Steam	None	......
Brookline	Steam	Steam	None	......
Cambridge	Steam	Steam	None	......
Chicopee	Electric	Electric	Steam	Electric
Concord	Electric	......	None	......
Danvers	Steam	None	None	......
Easthampton	Electric	......	None	......
Fall River	Steam & elec.	Electric	None	......
Falmouth	Steam	Steam	None	......
Greenfield	Electric	Gravity	......	......
Haverhill	Steam	Steam	None	......
Holbrook	Steam	Steam	None	......
Hyannis	Oil	Oil	None	......
Lawrence	Steam	Steam	None	......
Maynard	Steam	Steam	None	......
Midway	Oil	None	None	......
Milford	Steam	None	None	......
Montague	Electric	Rife Ram	None	......
New Bedford	Steam	Electric	None	......
Newburyport	Steam & elec.	Steam	None	......
North Adams	None	Steam	None	......
North Andover	Steam	Steam	None	......
Orange	Water power	Steam & elec.	None	......
Oxford	Oil	Oil	None	......
Peabody	Steam	......	None	......
Reading	Steam	Steam	None	......
Shrewsbury	Oil	Oil	None	......
Spencer	None	Gasoline	......	......
Waltham	Steam	Steam	None	......
Wellesley	Electric	Steam	None	......
Weymouth	Electric	Steam	Steam	Electric
Michigan:				
Albion	Steam	Electric	None	......
Alma	Electric	Oil	Steam	Oil & electric
Cheboygan	Electric	Steam	Steam	Electric
Coldwater	Steam & elec.	......	None	......
Crystal Falls	Water power	Water power	None	......
Dowagiac	Steam	Electric	None	......
Escanaba	Steam	Steam	None	......
Hancock	Steam & elec.	Electric	None	......
Hastings	Steam	Steam	None	......
Highland Park	Electric	Electric	......	......

PUMPING PLANTS—(Continued)

City	Kind in Regular Service	Kind in Reserve	Change Made During Past Five Years: From	To (or plant added)
Michigan—(Continued):				
Houghton	Electric	Electric	None	......
Iron Mountain	Electric	Gasoline	......	Electric
Jackson	Steam	......	......	Electric added
Ludington	Steam	Steam	None	......
Manistique	Electric	Gasoline	......	Gasoline added
Marquette	Steam & elec.	None	None	......
Marshall	Electric	Steam	None	......
Menominee	Steam	Steam	None	......
Mt. Clemens	Steam & elec.	Steam	......	Electric
Mt. Pleasant	Water power	Electric	......	Electric added
Muskegon Heights	Electric	......	None	......
Niles	Electric & water power	None	......	Electric added
Otsego	Water power & electric	Electric	None	......
Petoskey	Electric	Steam	......	Electric
St. Clair	Elec. & gaso.	......	Steam	Electric
South Haven	Steam	Steam	None	......
Traverse City	Electric	Steam	......	2 electric
Minnesota:				
Alexandria	Electric	Steam	......	......
Bemidji	Electric	Elec. & steam	None	......
Cloquet	Electric	Gasoline	None	......
Crookston	Electric	Steam	None	......
Duluth	6 elec., 2 gas	Steam, gas & gasoline	None	......
Fairmont	Electric	None	None	......
Hutchinson	Elec. & steam	......	......	2 elec. added
International Falls	Electric	Steam	None	......
Lake City	Steam & elec.	Fairb'ks-Morse	......	1 elec. added
Minneapolis	Electric	Steam	None	......
Montevideo	Electric	Electric	None	......
Moorhead	Electric	Electric	None	......
Northfield	Electric	......	......	......
St. Peter	Electric	Steam	None	......
Staples	Electric	Steam	Steam	Electric
Stillwater	Electric	Steam	None	......
Two Harbors	Steam	Steam	None	......
West. Minneapolis	Steam & elec.	Steam	......	Electric
Willmar	Electric	Steam	None	......
Mississippi:				
Amory	Electric	......	Steam	Electric
Canton	Steam	Steam	None	......
Charleston	Electric	Electric	Changing now	To oil
Clarksdale	Electric	Steam	......	......
Greenville	Electric	Steam	None	......
Jackson	Steam	Steam	None	......
Laurel	Electric	Steam & gas	Steam	Electric
New Albany	Steam & elec.	Steam & elec.	......	Electric added
Vicksburg	Steam	Steam	None	......
Missouri:				
Hannibal	Steam	......	......	......
Higginsville	Electric	Steam	......	......
Liberty	Electric	Electric	Steam	Electric
Marceline	Electric	None	None	......
Marshall	Steam	......	Steam	Elec. at wells
Poplar Bluff	Electric	Steam	Steam	Electric
Richmond	Electric	Steam	......	Electric
St. Louis	Steam	Steam	None	......
Trenton	Electric	......	Steam	Electric
Montana:				
Billings	Electric	Electric	None	......
Glendive	Electric	None	None	......
Great Falls	Electric	......	......	......

City	Kind in Regular Service	Kind in Reserve	Change Made During Past Five Years: From	To (or plant added)
North Carolina—(Continued):				
Greensboro	Steam	Steam	None	......
Henderson	Electric	Steam	None	......
Kings Mountain	Electric	None	None	......
Kinston	Steam & elec.	Steam	......	Electric
Mooresville	Electric	None	None	......
Newton	Electric	Gasoline	None	......
Spencer	Electric	Connection to Salisbury W.W.	None	......
Statesville	Electric	Steam	Steam	Electric
Wilmington	Electric	Steam	Steam	Electric
North Dakota:				
Fargo	Electric	Steam	Steam	Electric
Mandan	Electric	Electric	None	......
Valley City	Electric	Electric	None	......
Wahpeton	Electric	Steam	None	......
Williston	Elec. & gasoli.	Gasoline	None	......
Ohio:				
Akron	Steam	Electric & steam turbine	None	......
Athens	Electric	Electric	None	......
Barberton	Steam & elec.	......	......	Electric
Barnesville	Steam	......	None	......
Cincinnati	Steam	Steam	None	......
Conneaut	Steam	Steam	None	......
Coshocton	Steam	Steam	None	......
Dayton	Steam & elec.	Steam & elec.	None	......
Defiance	Electric	Gasoline	Steam	Elec. & gaso.
East Liverpool	Steam	Steam	None	......
Eaton	Steam	Steam	None	......
Elyria	Steam	......	None	......
Findlay	Steam	Steam	None	......
Freemont	Steam	Steam	None	......
Galion	Steam	......	Now changing	Electric
Gallipolis	Oil	Steam	Steam	Oil
Kent	Electric	Gasoline	Steam	Electric
Lancaster	Elec. & steam	Steam	......	Electric
Lorain	Steam	Steam	None	......
Marietta	Steam	Steam	None	......
Medina	Natural gas	Oil	......	Oil added
Miamisburg	Steam	......	......	......
Mingo Junction	Gas	Steam	None	......
Montpelier	Steam	Steam	None	......
Niles	Electric	None	None	......
Sidney	Electric	Steam	......	Electric
Struthers	Gas & oil comb. & electric	Same as regular service	None	......
Tiffin	Steam & water power	Electric	None	......
Toledo	High service, steam, low elec.	Natural gas	......	......
Upper Sandusky	Natural gas	Gasoline	None	......
Urbana	Steam	Steam	None	......
Willoughby	Electric	None	None	......
Wilmington	Electric	Steam	One steam	Electric
Oklahoma:				
Ada	Hydraulic & electric	......	......	Electric added
Clinton	Electric	None	None	......
Guthrie	Electric	Gasoline	......	......
Henryetta	Steam & Elect	Steam & elec.	None	......
Holdenville	Steam	Steam	None	......
McAlester	Steam	Steam	None	......
Mangum	Electric	Electric	None	......
Newkirk	Electric	None	None	......
Okmulgee	Steam with oil & gas fuel, elec.	Same as regular service	None	......

Havre	Electric	Electric	None	......
Kalispell	Electric	Steam turbine	None	.....
Miles City	Electric	Electric	None	......
Whitefish	Gravity sys.	Gas & electric	None	......
Nebraska:				
Auburn	Electric	Steam	Steam	Electric
Aurora	Electric	None	......	Electric
Columbus	Electric	Electric	None	......
Fremont	Steam & elec	Steam	None	......
Grand Island	Steam & elec.	Steam	None	......
Holdrege	Steam & elec.	......	......	......
Kearney	Steam	Electric	......	Electric
Schuyler	Electric	Steam	None	......
Sidney	Electric	None	None	......
University Place	Electric	......	None	......
New Hampshire:				
Claremont	Gravity sys.	Steam (not used for 8 yrs.)	......	......
Dover	Electric	Steam	......	......
Lebanon	Water power	Electric	None	......
Somersworth	Steam	......	None	......
New Jersey:				
Bayonne	Electric	Electric	None	......
Bridgeton	Steam	Electric	None	......
Cape May	Steam	......	None	......
Egg Harbor	Electric	Gas & gasoline	Gasoline	Electric
Hightstown	Electric	Kerosene	Steam	Electric
Merchantville	Electric	Steam	Steam	Electric
New Brunswick	Steam, water power & elec.	......	......	......
Phillipsburg	Steam	Steam	None	......
Westfield	Steam	None	None	......
New Mexico:				
Albuquerque	Steam & elec.	......	None	......
Deming	Electric	Electric	None	......
New York:				
Amityville	Electric	Gasoline	Gasoline	Electric
Auburn	Steam	Steam	None	......
Brockport	Steam	Steam	......	......
Canastota	None	Gasoline	......	......
Canton	......	Steam	......	......
Corning	Nat. gas & elc.	......	......	......
Cortland	Steam	......	None	......
Elmira	Electric	Steam	None	......
Fairport	Electric	Electric	......	......
Geneva	Steam	Steam	......	......
Glens Falls	Gravity sys.	Electric	None	......
Herkimer	Electric	Elec. & steam	Steam	Electric
Hoosic Falls	Water power	Steam	......	......
Hudson Falls	Electric	Gasoline	None	......
Johnson City	Steam turbine	Steam turbine	Electric	Steam
Lyons	Electric	Electric	None	......
Malone	......	Electric	None	......
Mechanicsville	Steam	Steam	None	......
Mohawk	Electric	......	None	......
Mt. Vernon	Electric	None	Steam	Electric
New York	Steam & elec.	Steam & elec.	None	......
Norwich	......	Electric	None	......
Ogdensburg	Wat. pr & elec.	Steam	None	......
Oswego	Steam	Steam	None	......
Peekskill	Steam turbine	Electric	None	......
Scarsdale	Electric	Gasoline	New 1922	......
Scotia	Electric	None	None	......
Seneca Falls	Electric	Gasol. & steam	Steam	Electric
Solvay	Electric	None	None	......
Syracuse	Gravity sys.	Elec. booster, summers only	None	......
Tarrytown	Steam	Steam	None	......
Waterford	Electric	Steam	Steam	Electric
Watertown	Water power	Electric	None	......
Wellsville	Electric	Electric	None	......
North Carolina:				
Albermarle	Electric	Gasoline	......	Gas added
Gastonia	Electric	Gasoline	......	......
Pauls Valley	Electric	Electric	None	......
Stillwater	Electric	None	None	......
Walters	Electric	Steam	None	......
Oregon:				
Albany	Electric	Electric	Water power	Electric
Corvallis	Steam	Gravity	None	......
Pennsylvania:				
Allentown	Steam	Electric	......	Electric added
Ambler	Electric	Electric	Steam	Electric
Barnesboro	Electric	Electric	None	......
Carbondale	Steam	Steam	None	......
Catasauqua	Steam	Steam	None	......
Connellsville	Steam	Steam	None	......
Danville	Steam	......	None	......
Duquesne	Electric	......	......	......
Elizabeth	Steam	Steam	None	......
Emporium	Steam	......	None	......
Franklin	Steam	......	None	......
Freeland	Electric	Electric	None	......
Freeport	Steam	Steam	None	......
Huntingdon	Electric	Electric	None	......
Indiana	Electric	None	Steam	Electric
Jersey Shore	......	Steam	None	......
Johnsonberg	Electric	Electric & gas	None	......
Juniata	Electric	......	Oil	Electric
Kittanning	Steam	Steam	None	......
Lancaster	Electric	Gasoline	......	Gasoline added
Lebanon	Steam	......	None	......
McDonald	Steam	Electric	......	Electric
Meadville	Steam	Steam	None	......
Meyersdale	Steam & elec.	......	......	......
Midland	Steam	Steam	None	......
Millersburg	Water & elec.	Producer gas	None	......
Monaca	Steam	Steam	None	......
Norristown	Steam	Steam	......	......
North East	Gas	Gas	None	......
Osceola Mills	Electric	......	None	......
Phoenixville	Electric	Electric	Steam	Electric
Pittsburgh	Steam & elec.	Steam	Gas	Coal & electric
Sayre	Steam	Steam	None	......
Sharpsville	Steam	Steam	None	......
Titusville	Steam & gas	Steam & gas	None	......
Warren	Steam	Steam	None	......
Wellsboro	None	Fuel oil, air lift	Gasoline	Oil
Rhode Island:				
East Providence	Electric	Elec. & w. p.	None	......
Narragansett Pier	Electric & oil	Oil	Steam	Electric
Pascoag	Electric	Steam	None	......
Pawtucket	Steam	Steam & elec.	None	......
Providence	Steam & elec.	Steam & elec.	None	......
Woonsocket	Electric	Steam	None	......
South Carolina:				
Abbeville	Electric	Electric	......	......
Batesburg	Electric	......	......	......
Bennettsville	Steam & elec.	Steam	None	......
Charleston	Steam	Oil & electric	None	......
Cheraw	Electric	Gasoline	None	......
Columbia	Elec. & w. p.	Steam	None	......
Darlington	Electric	Steam	None	......
Easley	Electric	Steam	......	......
Florence	Hydro-electric	Steam & elec.	Steam	Electric
Greenville	Gravity sys.	Electric	......	......
Greenwood	Hydro-electric	Steam	......	......
Spartanburg	Steam & elec.	......	None	......
South Dakota:				
Brookings	Electric	Gas	......	......
Tennessee:				
Clarksville	Steam	Steam	None	
Dyersburg	Steam & elec.	......	None	......
Erwin	Electric	Gasoline	None	......
Fayetteville	......	Electric	None	......
Harriman	Steam	Steam	None	......

PUMPING PLANTS—(Continued)

City	Kind in Regular Service	Kind in Reserve	Change Made During Past Five Years — From	Change Made During Past Five Years — To (or plant added)
Tennessee—(Continued):				
Humboldt	Electric	Steam	None	......
Jackson	Steam	None	None	......
Memphis	Steam & elec.	Steam & elec.	Now changing	Steam turbine
Murfreesboro	Steam	Steam	None	......
Paris	Steam & elec.	Steam	None	......
Shelbyville	Electric	Electric (other sources)	Steam	Electric
Tullahowa	Electric	Electric	None	......
Texas:				
Cameron	Electric	Electric	......	......
Cleburne	Steam & elec.	Steam & elec.	......	Electric added
Corpus Christi	Oil	Oil	......	......
El Paso	Electric	Oil & steam	......	......
Ennis	Electric	......	None	......
Gainesville	Steam	Steam	None	......
Galveston	Steam, oil, elec.	Steam (with oil-electric)	Steam	Oil-electric
Graham	Oil	Steam	None	......
Jacksonville	Electric	Gasoline	Steam	Electric
Lockhart	Steam & elec.	......	......	Electric added
McKinney	Electric	Steam & elec.	......	Doubled cap'ty
Marlin	Steam	Steam	Now changing	Oil
Mart	Elec. c'trifugal	Elec. triplex	None	......
Memphis	None	Kerosene	None	......
Mineral Wells	Electric	Electric	Steam	Electric
Mt. Pleasant	Electric	Electric	......	......
Port Arthur	Electric	Steam	None	......
Quanah	Electric	Electric	Gas	Electric
Smithville	Steam & elec.	Steam	None	......
Sweetwater	Electric	......	None	......
Yoakum	Steam & elec.	Steam & elec.	None	......
Utah:				
All cities by gravity				
Vermont:				
Windsor	Electric	Electric	None	......
Virginia:				
Martinsville	Electric	Electric	None	......
Norfolk	Steam	Elec. & steam	None	......
Richmond	W. p. & elec.	Electric	None	......
Washington:				
Aberdeen	Gravity supply	Steam & steam turbine	None	......
Anacortes	Gasoline	Gasoline	......	......
Auburn	Electric	Electric	None	......
Bellingham	Steam & elec.	Electric	None	......
Ellensburg	Steam & elec.	Steam	None	......
Hoquiam	Electric	Steam	......	......
Pullman	Electric	None	None	......
Raymond	Electric	Gravity	None	......
Sedro Woolley and Burlington	Electric	Electric	None	......
Spokane	Hydraulic	Elec. & gasol'e	None	......
Tacoma	None	Steam & elec.	None	......
West Virginia:				
Beckley	Elec. & steam	......	None	......
Follansbee	Electric	Electric	Gas	Electric
Martinsburg	Steam & elec.	Electric	......	Electric added
Morgantown	Electric	Steam	None	......
Princeton	Steam	Air	None	......
Salem	Gas	Gas	None	......
Welch	Electric	Three circuits for power	None	......
Weston	Electric	Steam	Steam	Electric
Wisconsin:				
Appleton	Diesel oil	Electric	......	Electric
Baraboo	Electric	Hydraulic	None	......
Beaver Dam	Elec. & steam	Steam	Steam	Electric
Chippewa Falls	Electric	Steam	......	......
Clintonville	Electric	Steam	New plant	......
Cudahy	Steam	None	......	......
Delavan	Electric	Gasoline & oil	None	......
Edgerton	Steam	Electric	None	......
Hartford	Steam & elec.	......	One electric	Steam
Janesville	Steam	None	None	......
Jefferson	Electric	Steam	None	......
Kaukauna	Electric	Steam	None	......
Kenosha	Steam	Steam	None	......
La Crosse	Steam	None	None	......
Ladysmith	Electric	Gas. & steam	None	......
Lancaster	Steam	Steam	None	......
Madison	Steam	Steam	None	......
Manitowoc	Steam	Steam	......	Steam added
Marinette	Steam	Steam	None	......
Menasha	Electric	......	Oil	Electric
Menomonee	Electric	Electric	Steam	Electric
Merrill	Steam	Steam	......	......
Milwaukee	Steam	Steam	None	......
Monroe	Steam	Air compressor	None	......
Neenah	Electric	Steam	Steam	Electric
Racine	Steam	Steam	None	......
Reedsburg	Electric	Steam	None	......
Rhinelander	Steam	Steam	None	......
Ripon	Electric	Steam	None	......
Shawano	Steam & elec.	Steam	None	......
So. Milwaukee	Steam	Steam	None	......
Sparta	Electric	Steam	......	Electric
Stevens Point	Electric	None	Steam	Electric
Sturgeon Bay	Steam & elec.	......	......	......
Superior	Steam	None	None	......
Watertown	Steam, electric & gasoline	Gasoline	......	Elec. & gaso.
Wausau	Steam	Steam	None	......
Wauwatosa	Steam & elec.	Steam	None	......
West Bend	Electric	None	None	......
Whitewater	Steam	Steam	None	......
Wisconsin Rapids	Electric	Steam	None	......
Wyoming:				
Evanston	None	Electric	None	......
Rock Springs	Steam	Steam	None	......

Danvers Waterworks Notes

The Danvers, Mass., waterworks still contains a considerable amount of cement-lined pipe, there being about 2½ miles of 12 inch, 1.8 miles of 8 inch, 1.8 miles of 6 inch, nearly 12 miles of 4 inch, and nearly 9 miles of sizes smaller than 4 inch. Superintendent Roger W. Estey reports that the 12 inch cement-lined main feeder is giving remarkable service when it is considered that it has been in service since 1876. However, it is the policy of the city to replace the cement-lined pipe with cast-iron, two lines of cement-lined being so replaced last year.

It is realized that it would be desirable to have a greater number of gates in the distribution system in order to reduce the length of main that must be shut off in case of a break, and a number of gates were introduced for this purpose in old mains last year. Three gates in the system were found to be not working and were replaced. Three hydrant branches were furnished with gates during the year, and now the branches of all hydrants fed from the larger mains are provided with gates.

A telemeter float pipe was set in the gatehouse at the reservoir and a 2-wire insulated line was carried from the reservoir to the pumping station, being supported by the poles along the B. & M. R. R. This contrivance records at the pumping station the elevation of the water in the reservoir in tenths of a foot.

METERS IN DANVERS

The water commissioners of the town, in their report for 1923, state that "after reviewing the data collected during the past year from meters installed on services in a section of the town which was zoned off for the test purposes, they come to the conclusion that whatever fixture rates are now operative or may be operative in the future, no matter how carefully assessed, will not operate to curtail consumption or place the burden of costs of additional supplies on a basis of just assessment. This practice was perhaps more sound in theory ten years ago when water was more plentiful than it is today; but with additional supplies of water involving expenditures of hundreds of thousands of dollars and with distributing systems calling for heavy expenditures, it becomes vitally necessary to rigidly control consumption on a more sound and equitable basis of assessment; therefore, we are about to start working out details of a metering program to the final accomplishment of a 100% metered system."

During the year a test was made of all the large meters by the Pitometer Company, and all were cleaned and necessary repairs made. Roger W. Estey, superintendent of the Danvers Waterworks, reports that the Pitometer Company made two tests of the distribution system, in co-operation with the New England Insurance Exchange, and found the system to be in better condition than when a test was made in 1921. The Insurance Exchange made twenty different flow tests at different sections of the town, and a house-to-house inspection for leakage was made.

Slag Cement in Alabama

The State Highway Commission of Alabama has amended the specifications for constructing a project in Chilton county by adding the clause, "That in our specifications for roadbuilding, there be included slag cement as well as Portland cement in the construction of concrete bases for black top and brick pavements, subject to the approval of the Bureau of Public Roads."

Later R. E. Toms, acting district engineer of the Bureau, wrote state highway engineer, W. S. Keller: "In the event that it is your purpose to use Puzzolin cement in Project No. 100, in view of the more or less uncertain action of this cement under varying weather conditions, I would recommend that the following be considered as a revision of the specifications for this cement as outlined in your standard specifications, and that this revision be incorporated as a special provision for the project.

"Clause 141, Protection of Concrete. Immediately after finishing, the concrete shall be covered either by canvas suspended on frames or burlap placed on surfaces of concrete when same is sufficiently hardened to admit placing without marring the surface. (Time of hardening for placing burlap will generally be from two to five hours, depending on weather conditions and moisture content of surface.)

"This covering shall be thoroughly wet and maintained in place for twenty-four hours and then immediately replaced with a covering of straw of ample thickness, sand 2 inches thick, or other satisfactory material. This covering shall be kept wet for a period of eight days, and maintained in place for fourteen days under the most favorable conditions. It shall then be removed but no traffic admitted on the surface until twenty-one days after finishing has elapsed. At the end of twenty-one days, if in the opinion of the engineer the surface is in acceptable condition, the surfacing may be placed if the concrete has been mixed with Portland cement. If Puzzolan cement is used in the manufacture of the concrete, the same curing period and method as outlined above shall apply, but no surface shall be placed until after the expiration of forty days in summer weather.

"In the event that the work of construction in the Fall or Winter season and at any time when the average temperature shall be at 50 degrees or below, a period of sixty days shall be allowed before wearing surface is placed. If it should become necessary on account of the weather conditions or the condition of the concrete, these periods of forty and sixty days may be extended if deemed desirable by the engineer."

Mr. Toms also recommended that a similar clause be used on all future projects and requested that a complete test be made of such concrete bases as have already been made with this cement in Alabama, in order that the Bureau of Public Roads might be informed of the action of this cement and its relative value in highway.

Water Company Purchases Fire Engine

The water company that serves Shelby, Ohio, last year presented the Fire Department of that city with a combination pumping engine. Presumably this was done both for the general good of the city and also because it relieved the company of the necessity for raising pressure in its mains at time of fire.

Recent Legal Decisions

MINIMUM CHARGE IN WATER RATE SCHEDULE

The Pennsylvania Public Service Commission, in Belle Vernon v. Belle Vernon Water Co., No. 4827, holds that a minimum charge of $4.75 per quarter to domestic consumers, giving the patron who pays the minimum the right to use 6,000 gallons per quarter, should be reduced, for the reason that the company serves a large number of small consumers with the result that about two-thirds of its patrons pay the minimum, which is in effect a flat rate, and therefore do not benefit under the graduated rates.

POWER TO CONTRACT FOR UTILITY RATES AND TO REGULATE SAME HELD INCOMPATIBLE

The Texas statute, article 1018 of the Revised Statutes of 1911, authorizes cities and towns in that state of over 2,000 inhabitants to regulate rates to be charged by light companies, no rate to be prescribed which shall yield less than 10 per cent. on the actual cost of the company's physical property. The Texas Commission of Appeals, in City of Uvalde v Uvalde Electric & Ice Co., 250 S. W. 140, holds that a 10-year contract between the city and the light company was void, as being neither expressly or impliedly authorized.

The court said: "The grant of power by the Legislature to the city to regulate those rates was an exclusion of the power to make a contract for light rates that would suppress or suspend the expressly granted power to regulate. The power to regulate rates and the power to stipulate by contract for a term of 10 years for rates cannot coexist. If the city has the power thus to contract, then it has not the power so to regulate during the term of the contract.

"The rule has been established by the courts that the Legislature may by express words authorize municipal corporations to enter into contracts prescribing the rates that may be charged by public utility corporations for a defined time, and that such contracts do have the effect of suspending, during the life of the contract, the governmental power of regulating such rates. But for a contract to have that effect the authority to make it must be clear and unmistakable. All doubts must be resolved against the municipality's authority to make such a contract and in favor of the continuance of its governmental power."

The suit was one for injunction by the city and others to restrain the utility from increasing electric light rates. Judgment sustaining a general demurrer to the petition (235 S. W. 625) was affirmed.

LEASING PART OF BOULEVARD HIGHWAY FOR OILING STATION NOT A PUBLIC PURPOSE

The Washington Supreme Court holds, Reed v. City of Seattle, 213 Pac. 923, that a boulevarded street is none the less a public highway, though it is so widened as to be beautified by the construction of parking strips on its margin on which may be planted trees and shrubbery, and the city would not be authorized to let the parking strips for private uses, such as the construction of a gasoline filling station for automobiles, although such an oiling station may be a convenience to the public traveling in automobiles.

ALL RECOVERY OF ASSESSMENT FOR SIDEWALK CONSTRUCTION NOT DENIED ALTHOUGH COST EXCEEDS STATUTORY LIMIT

The Kentucky Court of Appeals holds, Town of Kevil v. Nuckols, 250 S. W. 84, that the fact that the construction of a sidewalk exceeded 50 per cent. of the value of the ground after the improvements were made, excluding value of the buildings and other improvements on the property improved, which is the limit fixed for assessment by section 3706 of Kentucky Statutes, did not warrant the denial of any recovery by the town for the improvement, but the town is entitled to a lien against the several lots benefited for the respective costs of the improvements made thereon to the extent of the statutory limit.

PUBLIC ENTITLED TO FULL WIDTH OF ESTABLISHED ROAD THOUGH OBSTRUCTIONS HAVE BEEN PERMITTED

The Kansas Supreme Court holds, State v. Paul, 213 Pac. 165, that a road regularly laid out and traveled by the public does not have to be used for its entire width in order to preserve its public character. Very few roads, except in highly congested communities, are so used. In sparsely settled rural districts, the beaten path is usually oft he width of the wagon tracks or those of other vehicles which travel thereon. Not infrequently prairie grass is mowed and garnered on the roadside; sometimes crops are grown thereon. None the less, the full width of the established road is for public travel and public use whenever the expanding needs of the public so require. The fact that adjacent property owners had been permitted to maintain hedges, fences, shade trees and other obstructions to the centre of the established road, and that public travel had always been on the other side of the road did not lessen the public's right to the use of the full width of the road in the present case.

INSUFFICIENT DESCRIPTION OF LOCATION OF SEWER INLETS IN ORDINANCE

The Illinois Supreme Court holds, City of Bloomington v. Davis, 309 Ill. 20, 140 N. E. 4, that ordinances for improvements must specify the nature, character and locality of the improvement. An ordinance providing for five cast-iron sewer inlets, sufficiently describing the inlets, but making no reference to the sewer with which they were to be connected except that they "shall be connected with the public sewer," and the plat showing nothing definite as inlets or manholes, was held to be invalid. The court cannot take judicial notice of the location of a sewer.